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ABSTRACT

This guide is intended to assist vocational educators in teaching a four-unit module in oxy-fuel cutting and welding. The module is part of a welding curriculum that has been designed to be totally integrated with Missouri's Vocational Instruction Management System. The following topics are covered in the module: oxyacetylene welding, oxyacetylene cutting, and additional processes. The materials included in the module have been formatted for competency-based teaching and testing. All information sheets, transparency masters, job sheets, assignment sheets, and test items are keyed to specific competencies, and a cross-reference table has been included to aid in identifying the parts of the curriculum that relate to specific competencies. Unit tests to evaluate specific competencies have also been provided. (MN)

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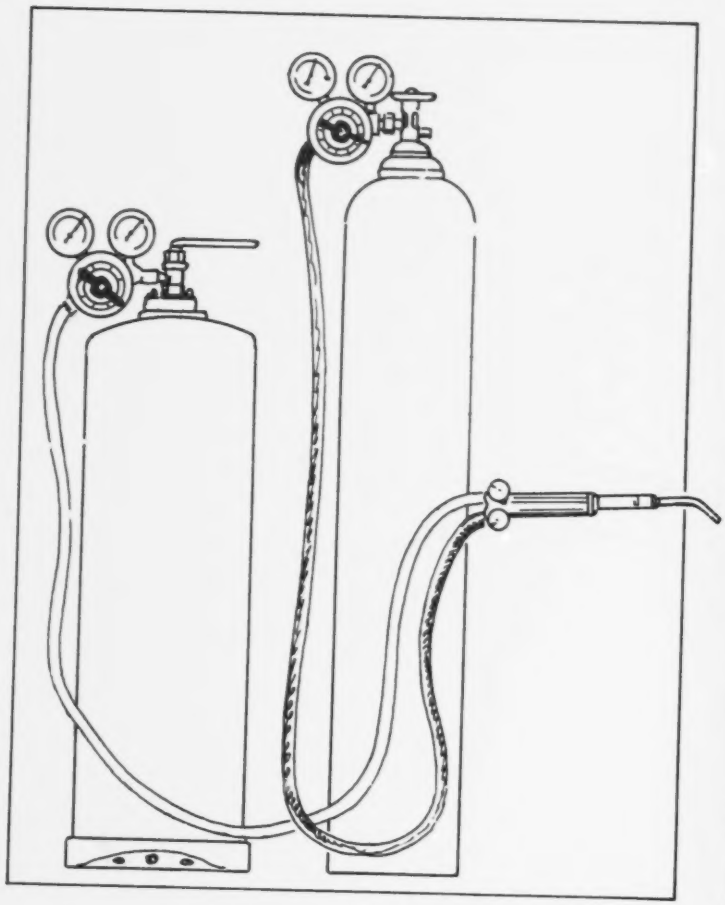
Instructor's Guide

ELDING • Module 3

Oxy-Fuel Cutting/Welding



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Module: Oxy-Fuel Cutting/Welding
Cross-Reference Table of Instructional Materials

Competency	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
C1	I 2.1, 2.2, 2.4	I 2.1		I 2.1		I 2-4, 6-8, II 14	
C2	I 2.3, 3.4, IV 3.1					I 1, 5, IV 26-28	
C3	I 2.3, 3.3					I 15-17, 22-25	
C4	I 1.4, 3.1, 3.2, 3.5, 3.6, II 1.1, 1.7, 1.8			I 1.1, 3.1	I 3.1, II 2.1	I 9-12, 18-21, 26-41 II 1-7, 10, 13, 17, IV 12, 14	
C5	II 1.2-1.6, 2.5, III 1.3-1.4, 2.2a	III 1.1	II 1.1-1.3, III 1.1	II 1.1	I 3.1, III 2.1	II 12, IV 15, 16	
C6	III 2.2c				III 2.4		
C7	III 1.6-1.9, 2.1, 2.2b, 3.2			III 1.1, 3.1	III 2.2, 2.3, 2.6, 3.1	II 16, III 1-38, IV 17	
C8	III 2.2c				III 2.4		
C9	III 2.2d, 2.2e				III 2.5, 2.6		
C10	II 2.8a				II 2.2		
C11	II 2.8b				II 2.3		
C12	II 2.8c				II 2.4		
C13	II 2.8d				II 2.5		
C14	II 2.8e				II 2.6		
C15	IV 1.1-1.4, 1.7a-c			IV 1.1	IV 1.1-1.3	IV 1-6	
C16	IV 1.5, 1.7b			IV 1.1	IV 1.4	IV 7-11, 25	
C17	II 2.7				II 2.6		
C18	II 2.2				IV 1.2, 1.3	IV 8, 9, 11, 13	
C19				II 1.1, IV 1.1			

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MODULE: OXY-FUEL CUTTING/WELDING

UNIT I: ORIENTATION

UNIT OBJECTIVES

Upon completion of this unit, the student should be able to explain the benefits of the oxyacetylene system and those safety requirements that deal directly with personal clothing, the work area and oxyacetylene equipment. The student should be able to safely set up an oxyacetylene system. This knowledge will be evidenced by achieving the specified score on the unit test and job sheet.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms and definitions related to oxyacetylene welding.

1.2 Complete statements concerning the history of oxyacetylene welding and cutting.

1.3 Complete statements concerning what beginners gain from learning oxyacetylene welding and cutting.

1.4 List equipment required for oxyacetylene cutting and welding.

2.1 Complete a list of safety rules for the oxyacetylene work area.

2.2 Select true statements concerning safe clothing requirements.

2.3 Complete statements concerning basic safety rules for oxy-acetylene cylinders and gases.

2.4 Complete statements concerning eye protection.

3.1 Complete statements concerning pressure-regulating valves.

3.2 Identify characteristics of various welding hoses.

3.3 Complete statements concerning set-up of cylinders and regulators.

3.4 Identify the steps of purging oxygen and fuel gas regulators.

3.5 Complete statements in the final steps of setting up oxy-fuel equipment.

3.6 Demonstrate the ability to light, adjust and shut off an oxyacetylene welding torch.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT I: ORIENTATION

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: INTRODUCTION TO OXYACETYLENE

   a. Information outline

   b. Assignment sheet

      AS 1.1: Oxyacetylene welding and cutting

   c. Answers to assignment sheet

2. Lesson 2: SAFETY

   a. Information outline

   b. Transparency master

      TM 2.1: Cylinder and gas safety

   c. Assignment sheet

      AS 2.1: Safety and set-up

   d. Answers to assignment sheet

3. Lesson 3: EQUIPMENT SET-UP PROCEDURES

   a. Information outline

   b. Assignment sheet

      AS 3.1: Equipment set-up

   c. Answers to assignment sheet

   d. Job sheet

      JS 3.1: Light, adjust and shut off an OA torch

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Operator's Manual for Oxy-Fuel Gas Cutting. Miami: American Welding Society, 1978.

2. Instruction Manual, Welding and Cutting, and Lead-Burning. St. Louis: Modern Engineering Company, Inc., 1970.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Oxy-acetylene Welding and Cutting. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Have students read the material and complete the assignment sheets before performing Job Sheet 1.

B. Suggested student activities

1. By helping first-year students, second-year students reinforce their own learning.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT I: ORIENTATION

LESSON 1: INTRODUCTION TO OXYACETYLENE

I. Terms and definitions

A. Base metal--metal to be welded, brazed or cut

B. Fusion welding--welding process that brings materials to a melting point, which allows them to fuse or flow together before cooling (with or without filler or pressure)

C. Interpass heating--application of heat to a base metal during a welding process

D. Oxyacetylene welding--process which joins metals by heating them to melting point with acetylene and oxygen gases, allowing the melted portions to flow together (with or without a filler metal)

E. Oxy-fuel welding--process where welding heat results from the combustion of oxygen and any fuel gas other than acetylene

F. PSI--pounds per square inch (pressure measurement)

G. Penetration--distance from the original surface of the base metal to that depth at which fusion stops

H. Postheating--heating after a welding operation to provide uniform cooling and stress relief

I. Preheating--heating prior to a welding or cutting operation

J. Stress relief--a process whereby base metals are heated to even temperature below the critical range, held at that temperature for a given time, and uniformly cooled to avoid distortion, cracking or other stress-related problems

K. Tack weld--a short weld used to hold workpiece in place temporarily

II. History of oxyacetylene welding and cutting

A. Acetylene was discovered in England in 1836 by Edmund Davey and was eventually produced from calcium carbide, which was first used for residential lighting.

B. In 1895, a French chemist discovered that acetylene and oxygen together produced a hotter flame than any other gas or combination of gases.

C. Another Frenchman developed an injector-type acetylene torch in 1900. It was introduced in America in 1906.

D. During the early 1900s, oxyacetylene became the major welding process in industry, construction, maintenance and repair because the systems were readily portable and the process could be used on almost all types of metals.

E. Faster arc welding processes such as shielded metal arc, GTAW and GMAW have replaced oxyacetylene in many industrial applications.

F. Oxyacetylene continues to be used for many maintenance and repair applications; is popular for farm equipment repairs; and is still a popular cutting process in both maintenance and industry.

III. What beginners gain from learning oxyacetylene welding and cutting

A. How to form, recognize and control a weld puddle

B. How to hold and manipulate welding equipment properly and to develop techniques that are useful in other welding processes

C. Good eye-hand coordination

D. The basics of metallurgy and the characteristics of metals being welded or cut

E. A familiarity with the welding work place and its activities

F. A welding skill that will increase their employability when they face job demands that require both arc and oxyacetylene skills

IV. Equipment required for oxyacetylene welding (TM 1.1)

A. Oxygen cylinder

B. Acetylene cylinder

C. Pressure regulator for oxygen

D. Pressure regulator for acetylene

E. Two hoses encased together

F. Welding torch with assorted tips and cutting attachment

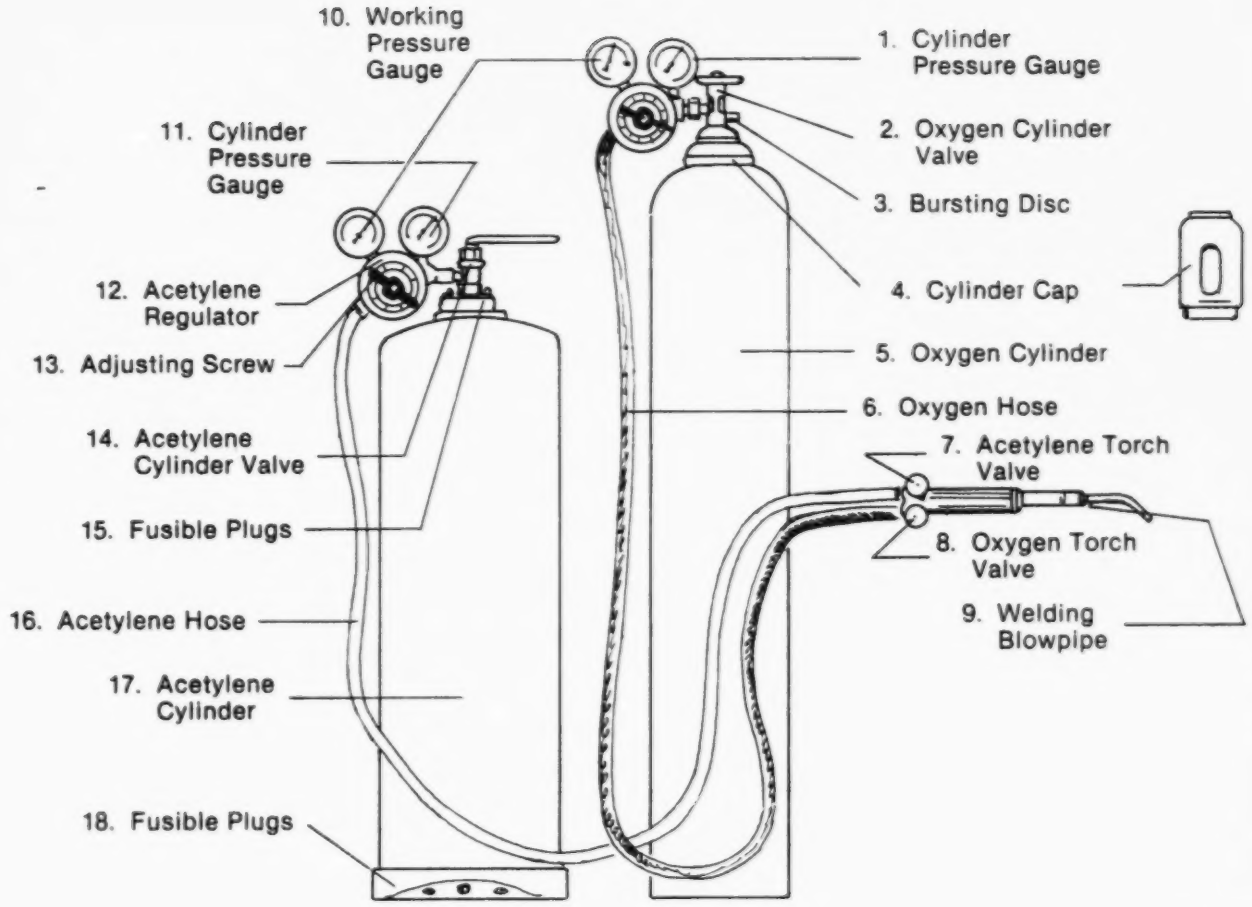
G. Welding goggles

H. Sparklighter

I. Check valves to prevent flashback

CAUTION: Never use a welding or cutting torch that does not have check valves.

Oxy-acetylene Welder



OXYACETYLENE WELDING AND CUTTING

Match terms on the right with appropriate definitions.

___ 1. Welding process that joins metals by heating them to a melting point and allowing them to fuse or flow together before cooling

___ 2. Distance from the original surface of the base metal to the depth at which fusion stops

___ 3. Metal to be welded, brazed or cut

___ 4. A short weld used to hold workpiece in place temporarily

___ 5. Heating prior to a welding or cutting operation

___ 6. Application of heat to a base metal during a welding process

___ 7. Heating after a welding operation to provide uniform cooling and stress relief

___ 8. A process whereby base metals are heated to even temperature below the critical range, held at that temperature for a given time and uniformly cooled to avoid distortion, cracking or other stress-related problems

a. Base metal
b. Fusion welding
c. Interpass heating
d. Penetration
e. Postheating
ab. Preheating
ac. Stress relief
ad. Tack

Select the word(s) that best complete(s) each statement.

___ 9. Acetylene was discovered in _____ in 1836.

a. America
b. England
c. France
d. Germany

___ 10. In the early 1900s, oxyacetylene became the major welding process in industry, construction, maintenance and repair because ____ .

a. It was new
b. Of its low cost
c. Of its portability and adaptability
d. It was better than GTAW

___ 11. Faster arc welding processes such as _____ have replaced oxyacetylene welding in many industrial applications.

a. Brazing and GTAW
b. Brazing and SMAW
c. Brazing and GMAW
d. SMAW, GTAW and GMAW

12. List three benefits that beginners gain from learning oxyacetylene welding.

a.

b.

c.

13. Name four pieces of equipment necessary for oxyacetylene welding.

a.

b.

c.

d.

ANSWERS TO ASSIGNMENT SHEET 1.1

1. b
2. d
3. a
4. ad
5. ab
6. c
7. e
8. ac
9. b
10. c
11. d

12. Any three of the following:
    a. How to form, recognize and control a weld puddle
    b. How to hold and manipulate welding equipment properly and to develop techniques that are useful in other welding processes
    c. Good eye-hand coordination
    d. The basics of metallurgy and the characteristics of metals being welded or cut
    e. A familiarity with the welding work place and its activities
    f. A welding skill that will increase their employability when they face job demands that require both arc and oxyacetylene skills

13. Any four of the following:
    a. Oxygen cylinder
    b. Acetylene cylinder
    c. Pressure regulator for oxygen
    d. Pressure regulator for acetylene
    e. Two hoses encased together
    f. Welding torch with assorted tips and cutting attachment
    g. Welding goggles
    h. Sparklighter
    i. Check valves to prevent flashback

MODULE: OXY-FUEL CUTTING/WELDING

UNIT I: ORIENTATION

LESSON 2: SAFETY

I. Safety rules for the work area

A. Keep work area free of grease, oil and flammable materials because flying sparks can travel several feet and cause a fire.

B. Cool or quench hot metal and extinguish all sparks before leaving the work area, but do not quench during the welding process.

C. Do not leave torches, tips or hot metal where they can be accidentally touched by a co-worker or visitor.

D. Never carry matches or lighters filled with butane or propane into a work area where any kind of welding or cutting is taking place.

II. Clothing requirements

A. Shirts: Keep collar and sleeves buttoned to keep out sparks. Remove pockets from front of shirt or tape them shut if they don't have pocket flaps.

B. Pants: no cuffs, should be long enough to cover tops of shoes

CAUTION: Clothes made of polyester and other synthetics catch fire easily, so wear wool or heavily-starched cotton. Frayed clothing of any kind is dangerous.

C. Welding cap: worn to protect scalp from sparks and spatter

CAUTION: Some hair sprays are highly flammable and can be ignited by sparks. Any kind of plastic hair cap or covering is dangerous in welding areas.

D. Shoes: high tops of tough leather, steel toes are recommended

CAUTION: Never wear sneakers, tennis shoes or loafer-type shoes when welding.

E. Gloves: leather with gauntlets

CAUTION: Use pliers or another suitable tool for handling hot metal. When quenching metal, wear gloves for protection from steam and hot water. Quench the entire piece quickly.

III. Basic safety rules for oxyacetylene cylinders and gases (TM 2.1)

A. Secure cylinder in a vertical position. Make sure area is clean.

CAUTION: When blowing out cylinder valves, direct valves away from yourself and others. Blow out cylinder valves before attaching regulators.

B. Release adjusting screw on regulators before opening cylinder valves.

C. Stand to the opposite side of regulator when opening cylinder valve.

D. Open cylinder valve slowly.

E. Do not use or compress acetylene at pressures higher than 15 PSI.

F. Purge oxygen and fuel gas lines before lighting torch.

G. Light acetylene before opening oxygen valve on torch.

H. Never use oil on regulators, torches, fittings or other equipment in contact with oxygen.

I. Do not use oxygen as a substitute for compressed air.

J. Keep heat, flames and sparks away from combustibles.

IV. Eye protection required for oxyacetylene welding

A. Wear safety glasses at all times.

B. Wear safety glasses and a face shield when grinding joints or bevels.

C. Wear welding goggles to protect eyes from spatter. Choose goggles with a lens shade dark enough to protect eyes from radiation burns.

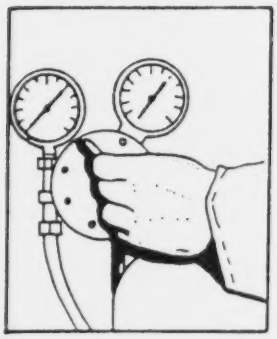
Type of welding	Metal thickness	Shade no.
Brazing	---	3
Light	Up to 1/8"	4 or 5
Medium	1/8 to 1/2"	5 or 6
Heavy	1/2" +	6 or 8

D. Play it safe--start with a lens shade too dark to see the work zone, then work down to a lighter shade that affords a good view of the work zone without straining your eyes.

CYLINDER AND GAS SAFETY

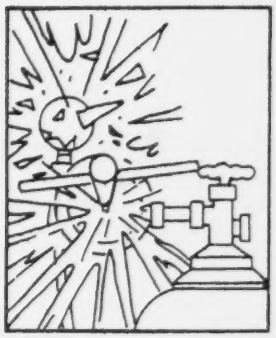
A.

B.



C.

D.



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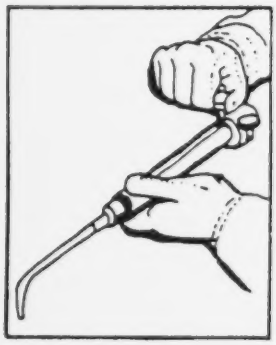
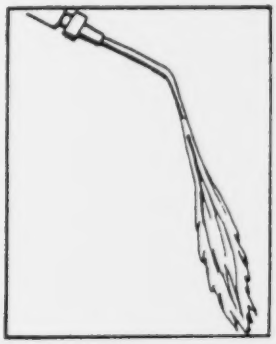
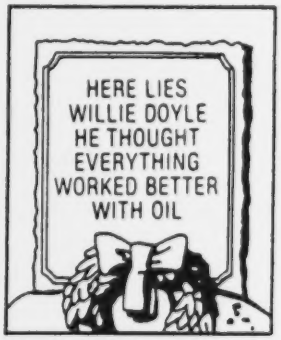
F.



G.



H.



I.

J.

OACW 15

SAFETY AND SET-UP

Complete the following set-up rules by selecting the word(s) that best complete(s) each statement.

____ 1. What should be done before leaving a work area but not during a welding process?

a. Close acetylene cylinder valve
b. Cool or quench hot metal and extinguish all sparks
c. Close oxygen cylinder valve
d. Drain fuel lines
e. All of the above

____ 2. Do not leave _____ where they can be accidentally touched by a co-worker or visitor.

a. Torches, tips or hot metal
b. Grease, oil or flammables
c. Butane or propane
d. Fuel cylinders

____ 3. Never carry _____ into any work area where any kind of welding or cutting is taking place.

a. Mirrors
b. Matches or lighters filled with butane or propane
c. Cigarettes
d. All of the above

____ 4. Which are appropriate pieces of welding apparel?

a. Pocketless shirts, heavyweight pants, denim gloves
b. Pocketless shirts, sneakers, blue jeans
c. Pocketless shirts, sneakers and a welding cap
d. Pocketless shirts, heavyweight pants, leather gloves with gauntlets

____ 5. Secure cylinder in _____ position before blowing out cylinder valves and attaching regulators.

a. A horizontal
b. An angular
c. A vertical
d. A convenient

____ 6. Release adjusting screw on regulators _____ .

a. After opening cylinder valves
b. Before opening cylinder valves
c. While opening cylinder valves
d. None of the above

___ 7. When opening the cylinder valve, stand _____ .

a. To the opposite side of the regulator
b. On the same side of the regulator
c. Close to the regulator to protect it
d. On insulated mat

___ 8. Do not use or compress acetylene at pressures higher than ____ .

a. 5 PSI
b. 10 PSI
c. 15 PSI
d. 30 PSI

___ 9. Before lighting the torch, _____ oxygen and fuel gas lines.

a. Wash out
b. Swab out
c. Purge
d. Dry

___ 10. Never use _____ on regulators, torches, fittings or other equipment in contact with oxygen.

a. Leak detector
b. Oil
c. Cylinder wrench
d. Soapy water

___ 11. What kind of clothing should be worn while grinding?

a. Safety glasses, face shield, heavyweight pants
b. Safety glasses, gloves, tennis shoes
c. Face shield, gloves, tennis shoes
d. Safety glasses, heavyweight pants, cotton gloves

___ 12. Which lens shade should be worn when welding thick metals?

a. #6 or above
b. #3
c. #4
d. #2

INSTRUCTOR'S NOTE: Completion of this assignment sheet to specified score is the student's final evaluation for competency C1: Demonstrate safety procedures.

ANSWERS TO ASSIGNMENT SHEET 2.1

1. e
2. a
3. b
4. d
5. c
6. b
7. a
8. c
9. c
10. b
11. a
12. a

MODULE: OXY-FUEL CUTTING/WELDING

UNIT I: ORIENTATION

LESSON 3: EQUIPMENT SET-UP PROCEDURES

I. Pressure regulating valves

A. Each cylinder is equipped with a pressure regulator when in service. The pressure regulators have two functions.

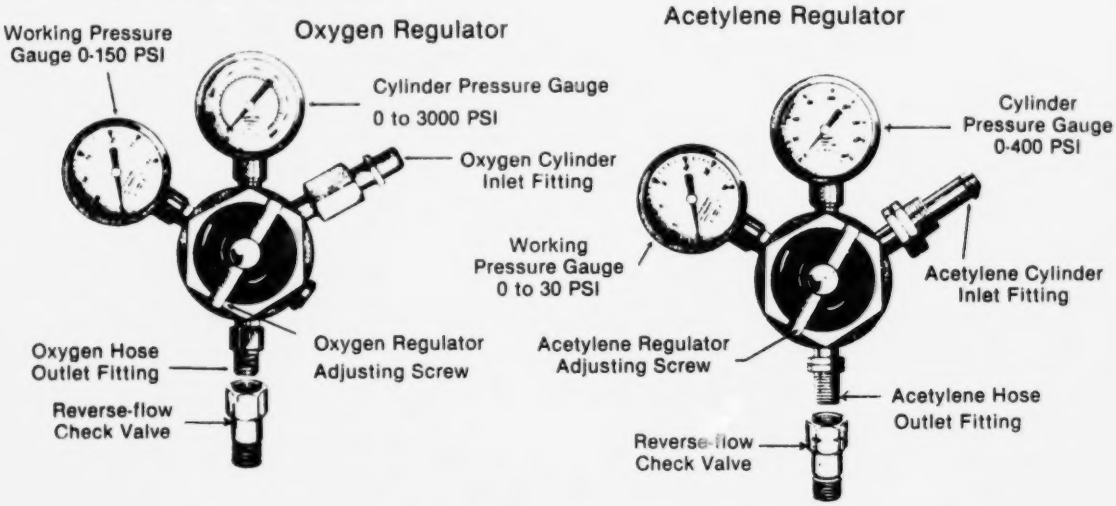
1. They reduce cylinder pressure to the required working pressure.

2. They produce a steady flow of gas under varying cylinder pressures.

B. Regulators have two gauges.

1. The one nearest the oxygen cylinder fitting is the cylinder pressure gauge. It indicates pounds per square inch (PSI).

2. The other is the working pressure gauge, which indicates amount of gas pressure being sent to the torch.


Oxygen Regulator
Working Pressure Gauge 0-150 PSI
Cylinder Pressure Gauge 0 to 3000 PSI
Oxygen Cylinder Inlet Fitting
Oxygen Hose Outlet Fitting
Reverse-flow Check Valve
Oxygen Regulator Adjusting Screw
Acetylene Regulator
Cylinder Pressure Gauge 0-400 PSI
Working Pressure Gauge 0 to 30 PSI
Acetylene Cylinder Inlet Fitting
Acetylene Regulator Adjusting Screw
Acetylene Hose Outlet Fitting
Reverse-flow Check Valve

C. Each regulator is also equipped with an adjusting screw. Turning the adjusting screw clockwise increases the working pressure, while a counter-clockwise adjustment decreases pressure.

II. Welding hose characteristics

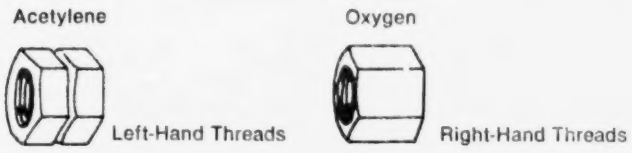
A. Transport--Special nonporous hoses are used to transfer the gases from the cylinders to the torch.

B. Color--Acetylene hoses are always red; oxygen hoses are usually green and sometimes black.

C. Connectors

1. Acetylene connectors have a V-groove and left-handed threads.

2. Oxygen connectors have plain surfaces and right-handed threads.



D. New hoses are coated inside with a powder to provide storage protection. Before using the hoses, blow powder out by attaching each hose to the proper cylinder regulators and opening the regulator to about five pounds of pressure.

III. Steps in setting up cylinders and regulators

A. Secure cylinders with a chain to a cylinder cart or wall support.

B. Remove cylinder valve caps.

C. Examine cylinder valve threads for damage and wipe away any dust, oil or grease with a clean, dry cloth.

D. Stand to one side of the oxygen cylinder valve. Open it momentarily and then close it quickly to purge the valve. Repeat the process for the fuel gas cylinder.

E. Attach oxygen regulator to oxygen cylinder valve and tighten with proper cylinder wrench.

F. Attach fuel gas regulator to fuel gas cylinder valve and tighten with a wrench.

G. Close both regulators by turning each regulator adjusting screw counter-clockwise until tension is completely released on the adjusting screw.

IV. Steps in purging oxygen and fuel gas regulators

A. Stand to one side and open oxygen cylinder valve slowly until inlet pressure gauge needle moves slowly to maximum reading.

B. Purge oxygen regulator by turning the adjusting screw clockwise.

C. Stand to one side and open fuel gas cylinder valve. If it is an acetylene cylinder, open only one-half to three-quarters of a turn.

CAUTION: When a key wrench is used to open an acetylene cylinder, it should be left in place during all operations to permit rapid emergency shutdown.

D. Purge fuel gas regulator by turning the adjusting screw clockwise to open it for a second; then turn it counter-clockwise to close it.

V. Final steps in setting up oxy-fuel equipment

A. Attach check valves to regulators and hoses.

B. Attach hoses to regulators and tighten with a wrench.

C. Purge both hoses by opening each regulator individually for 3-5 seconds and then closing it.

D. Attach hoses to torch handle and tighten with a wrench.

E. Turn torch needle valves clockwise to close them; tighten with proper cylinder wrench.

F. Set pressure on each regulator by turning the individual adjusting screws clockwise until needle on working pressure gauge reads the desired pressure.

G. Brush a leak detector solution on all threaded connections to check for leaks. If bubbles form, retighten connections with a wrench and check them again.

CAUTION: A soap-and-water solution is <u>not</u> recommended since some soaps contain hydrocarbons.

H. Purge torch by opening fuel gas valve half a turn for two seconds, then close and repeat the process for oxygen.

EQUIPMENT SET-UP

Select the word(s) that best complete(s) each statement.

___ 1. Each regulator has two gauges. One gauge indicates the _____ ; the other indicates the _____ .

a. Cylinder pressure, torch working pressure
b. Cylinder pressure, cylinder volume
c. Torch working pressure, cylinder volume
d. Cylinder volume, temperature

___ 2. The pressure regulator adjustment screw quickly controls torch pressure. Screw movement _____ increases pressure, while _____ decreases pressure.

a. Counter-clockwise, clockwise
b. Upward, downward
c. Left, right
d. Clockwise, counter-clockwise

___ 3. Secure cylinders with a _____ to a cylinder cart or wall support.

a. Piece of wire
b. Chain
c. Some string
d. Padlock

___ 4. Examine cylinder valve threads for damage and wipe clean of any _____ .

a. Dust
b. Oil
c. Grease
d. All of the above
e. None of the above

___ 5. Attach oxygen regulator to oxygen cylinder valve and tighten it with _____ .

a. An adjustable wrench
b. A screwdriver
c. A cylinder wrench
d. A pliers

___ 6. Stand to one side and open oxygen cylinder valve _____ until inlet pressure gauge needle moves _____ to maximum reading.

a. Slowly, rapidly
b. Rapidly, rapidly
c. Rapidly, slowly
d. Slowly, slowly

____ 7. Stand to one side and open fuel gas cylinder valve. For an acetylene cylinder, open only _____ turn(s).

a. 1/2 to 3/4
b. 1/2 to 1
c. 1 1/2 to 2
d. 2 to 2 1/2

____ 8. Purge fuel gas regulator by turning the adjusting screw clockwise to open it for ____ ____ .

a. A second
b. 15 seconds
c. 30 seconds
d. One minute

____ 9. When setting up oxy-fuel equipment, each regulator should be set to _____ .

a. 20 PSI
b. 15 PSI
c. 12 PSI
d. 5-10 PSI

____ 10. Purge torch by opening fuel gas valve _____ , then closing and repeating the procedure for oxygen.

a. Half a turn for one second
b. Half a turn for two seconds
c. One turn for two seconds
d. Two turns for two seconds

INSTRUCTOR'S NOTE: Completion of this assignment sheet to specified score is the student's partial evaluation for competency C4: Identify, select and set up oxy-fuel welding and cutting equipment.

ANSWERS TO ASSIGNMENT SHEET 3.1

1. a
2. d
3. b
4. d
5. c
6. d
7. a
8. a
9. d
10. b

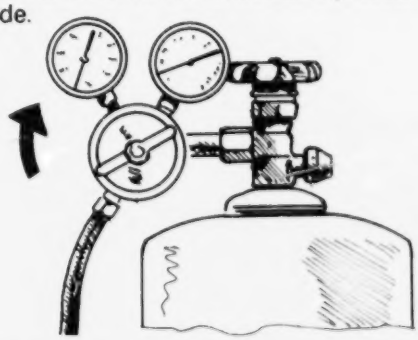
LIGHT, ADJUST AND SHUT OFF AN OA TORCH

Equipment:

Oxyacetylene cylinders and torch assembly
Sparklighter
Safety goggles
Welding gloves

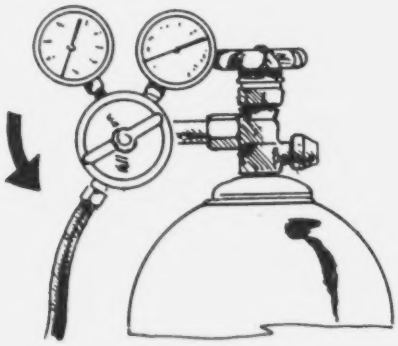
CAUTION: Do not carry a cigarette lighter filled with propane or butane while doing this procedure.

Procedure:	Evaluation 3 2 1 N
1. Inspect area to make certain it is clear of flammable materials and is well ventilated. Put on welding goggles and welding gloves. Inspect torch valves to make sure they are both turned off, then slightly open each valve adjustment screw.	— — — —
2. Check both regulator adjusting screws to be certain that all regulator pressure has been released before opening cylinders.	— — — —
NOTE: Opening adjustment screws slowly all the way helps prevent regulator rupture when the cylinder valve is opened.	
3. Open the acetylene cylinder valve slowly about half a turn past regulator pressure movement.	— — — —
CAUTION: Never open an acetylene regulator valve above 15 PSI because pressure beyond that point could cause the regulator to explode.	



4. Tighten the adjustment screw on the acetylene regulator until the acetylene regulator indicates the recommended pressure.	— — — —

5. Open the valve on the oxygen cylinder by slowly turning it counter-clockwise as far as it will go. — — — —



6. Tighten the adjustment screw on the oxygen regulator until it indicates recommended pressure. — — — —

7. Hold the torch in your dominant hand and point the tip down and away from you in a clear, safe area. — — — —

CAUTION: To avoid a dangerous build-up of acetylene, only one student at a time should perform this procedure. The area should be free of acetylene before another student attempts the purging procedure.

8. Purge both lines with the following procedure. — — — —

   a. Crack the acetylene adjustment screw on the torch with your other hand until you hear acetylene escaping from the end of the tip. Look at the acetylene regulator to see that it remains at recommended pressure.

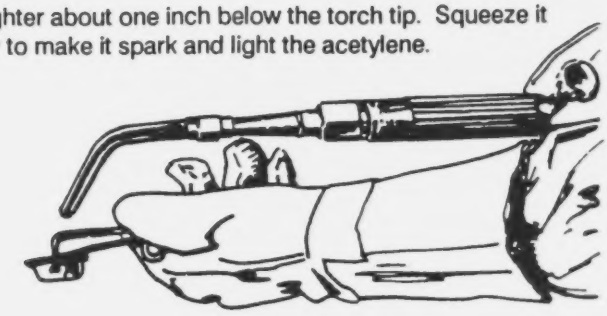
   b. Turn the acetylene adjustment screw on the torch off slowly. (Treat torch adjustment screws with care--forcing them quickly can damage them.)

   c. Repeat the procedure with the oxygen line, making sure the oxygen regulator remains at 10 PSI.

9. Keep the torch tip pointed down and away from you as you take the sparklighter in your other hand. Open the acetylene adjustment screw about a quarter turn. — — — —

NOTE: Acetylene produces a black smoke when it burns, so make the following adjustments as quickly as possible.

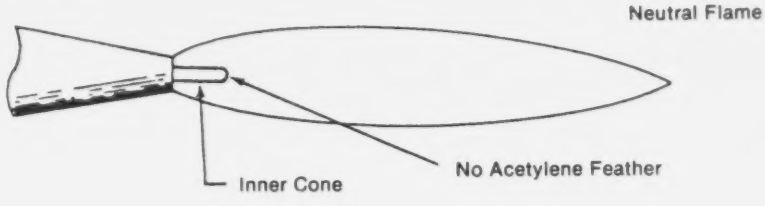
10. Place the sparklighter about one inch below the torch tip. Squeeze it quickly and firmly to make it spark and light the acetylene. — — — —



11. Open the torch acetylene valve only until the flame stops smoking. — — — —

12. Open the torch oxygen valve slowly to allow oxygen to mix with acetylene. Continue opening the torch oxygen valve until a neutral flame is achieved. — — — —

NOTE: Proper adjustment creates a neutral flame and indicates the correct mixture of oxygen and acetylene.



13. Continue moving the oxygen control valve slowly into different positions to purposely create improper flames, then readjust for a neutral flame. — — — —

14. Ask instructor to check your work. — — — —

15. Prepare to shut the equipment down. Close the acetylene and oxygen adjustment screws on the torch. — — — —

16. Close the acetylene and oxygen valves on the cylinder. — — — —

17. Open the torch's acetylene adjustment screw to bleed the acetylene line. Allow the regulator gauge to return to zero, then loosen the regulator adjustment screw and close the adjustment screw on the torch. — — — —

18. Repeat the previous step for the oxygen line. — — — —

19. Place hoses and torch back on the welding rack and secure all equipment. Ask instructor to check all valves. — — — —

20. Return welding goggles and gloves to proper storage area. — — — —

Average of above evaluations* — — — —

*This average is the student's final evaluation for competencies C4 and C5.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT: ORIENTATION

UNIT TEST

Match the term on the right with its definition on the left.

____ 1.	Process where welding heat results from the combustion of oxygen and any fuel gas other than acetylene	a.	Base metal
____ 2.	Distance from the original surface of the base metal to the depth at which fusion stops	b.	Color
____ 3.	Metal to be welded, brazed or cut	c.	Connector threads
____ 4.	A short weld used to hold workpiece in place temporarily	d.	Interpass heating
____ 5.	Process which joins metals by heating them to melting point with acetylene and oxygen gases, allowing the melted portions to flow together (with or without a filler metal)	e.	New hoses
		ab.	Oxyacetylene welding
____ 6.	Application of heat to a base metal during a welding process	ac.	Oxyfuel welding
____ 7.	Heating after a welding operation to provide uniform cooling and stress relief	ad.	Penetration
____ 8.	Process whereby base metals are heated to even temperature below the critical range, held at that temperature for a given time and uniformly cooled to avoid distortion, cracking or other stress-related problems	ae.	Postheating
		bc.	Stress relief
		bd.	Tack
____ 9.	Special nonporous hoses used to transfer gases from cylinders to the torch	be.	Transport
____ 10.	The visual indicator separating acetylene hoses from oxygen hoses		
____ 11.	Part on acetylene and oxygen couplings which has a different surface and mounting direction		
____ 12.	Coated inside with a powder to provide storage protection		

Choose the option which best answers the question or completes the statement.

____ 13. Acetylene was discovered in _____ in 1836.

a. America
b. England
c. France
d. Germany

____ 14. Learning oxyacetylene welding helps a beginning welder _____ .

a. Form, recognize and control a weld puddle
b. Hold and manipulate welding equipment properly and develop techniques useful in electronics
c. Learn the basics of metallurgy and characteristics of synthetic alloys
d. Achieve a welding skill that will decrease employability

____ 15. What is <u>not</u> a necessary safety component when performing oxyacetylene welding and cutting?

a. Goggles
b. Nonflammable clothing
c. Tip cleaner
d. Check valves

____ 16. What kind of clothing should be worn while grinding?

a. Safety glasses, face shield, heavyweight pants
b. Safety glasses, gloves, tennis shoes
c. Face shield, gloves, tennis shoes
d. Safety glasses, heavyweight pants, cotton gloves

____ 17. Which are appropriate pieces of welding apparel?

a. Pocketless shirts, heavyweight pants, denim gloves
b. Pocketless shirts, sneakers, blue jeans
c. Pocketless shirts, sneakers and a welding cap
d. Pocketless shirts, heavyweight pants, leather gloves with gauntlets

____ 18. Release adjusting screw on regulators _____ .

a. After opening cylinder valves
b. Before opening cylinder valves
c. While opening cylinder valves
d. None of the above

____ 19. <u>Never</u> use _____ on regulators, torches, fittings or other equipment in contact with oxygen.

a. Leak detector
b. Oil
c. Cylinder wrench
d. Soapy water

____ 20. Adjustment of the regulator adjusting screw determines the ____.

a. Tip size needed
b. Cylinder pressure
c. Working pressure
d. Thickness of allowable metal

___ 21. Acetylene hoses are _____ , while oxygen hoses are _____ .

a. Always red, always green
b. Blue, black
c. Red, white
d. Red, green or black

___ 22. Acetylene cylinder connector threads are _____, while oxygen connector threads are _____ .

a. Right-handed, left-handed
b. Right-handed, right-handed
c. Left-handed, right-handed
d. Left-handed, left-handed

___ 23. When setting up cylinders and regulators, always _____ attaching the regulators.

a. Purge the oxygen valve after
b. Purge the acetylene valve after
c. Purge the oxygen and acetylene valves while
d. Purge the oxygen and acetylene valves before

___ 24. When a key wrench is used to open an acetylene cylinder, it should be _____ to permit rapid shutdown in case of an emergency.

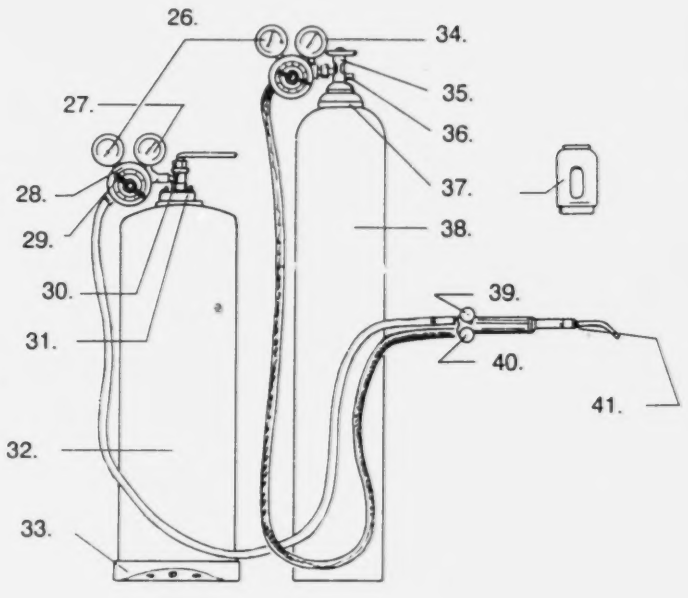
a. Kept in your pocket
b. Left in place during all operations
c. Left in place only during critical operations
d. Returned to the instructor

___ 25. Leak detector _____ be used to test for leaks on all threaded connections on the oxyacetylene welding outfit.

a. Should
b. Should not
c. Can sometimes
d. Can usually

Identify the parts of the oxyacetylene welder illustrated below.

___ 26.
___ 27.
___ 28.
___ 29.
___ 30.
___ 31.
___ 32.
___ 33.
___ 34.
___ 35.
___ 36.
___ 37.
___ 38.
___ 39.
___ 40.
___ 41.



a. Acetylene torch valve
b. Acetylene cylinder
c. Acetylene cylinder valve
d. Acetylene regulator
e. Adjusting screw
ab. Bursting disc
ac. Cylinder cap
ad. Cylinder pressure gauge
ae. Fusible plugs
bc. Oxygen torch valve
bd. Oxygen cylinder
be. Oxygen cylinder valve
cd. Working pressure gauge
ce. Welding blowpipe

ANSWERS TO UNIT TEST

1.	ac	(C2)
2.	ad	(C1)
3.	a	(C1)
4.	bd	(C1)
5.	ab	(C2)
6.	d	(C1)
7.	ae	(C1)
8.	bc	(C1)
9.	be	(C4)
10.	b	(C4)
11.	c	(C4)
12.	ab	(C4)
13.	b	
14.	a	
15.	c	(C3)
16.	a	(C3)
17.	b	(C3)
18.	b	(C4)
19.	b	(C4)
20.	c	(C4)
21.	d	(C4)
22.	a	(C3)
23.	d	(C3)
24.	b	(C3)
25.	a	(C3)
26.	ce	(C4)
27.	ad	(C4)
28.	d	(C4)
29.	e	(C4)
30.	c	(C4)
31.	ae	(C4)
32.	b	(C4)
33.	ae	(C4)
34.	ad	(C4)
35.	be	(C4)
36.	ab	(C4)
37.	ac	(C4)
38.	bd	(C4)
39.	a	(C4)
40.	bc	(C4)
41.	cd	(C4)

MODULE: OXY-FUEL CUTTING/WELDING

UNIT II: OXYACETYLENE WELDING

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify the proper equipment, tip size, flame type and filler material to perform welds with oxyacetylene in various positions and joints. This knowledge will be evidenced by achieving the specified score on the unit test and job sheets.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit the student should be able to:

1.1 Identify welding torch functions and mixer types.

1.2 Complete a chart of oxyacetylene flame types and characteristics.

1.3 Identify correct guidelines for flame adjustment.

1.4 Determine causes for various torch operation problems.

1.5 Select true statements concerning welding tip selection and its relation to other welding elements.

1.6 Match special purpose tips with uses.

1.7 Identify true statements concerning filler rod selection, handling and safety.

1.8 Complete statements concerning AWS rod designations and flux selection, handling and safety.

2.1 Identify welding positions.

2.2 Demonstrate elements of good fusion welding.

2.3 Select true statements concerning rod and torch angle rules of thumb.

2.4 Complete statements concerning characteristics of forehand and backhand techniques in fusion welding.

2.5 Identify statements concerning control of flame and rod motions.

2.6 Select true statements concerning joint preparation and heating.

2.7 Complete statements concerning clean-up, inspection and testing.

2.8 Demonstrate the ability to:

a. Run stringer bead without filler metal.*

b. Run stringer bead and joints with filler in flat position.*

c. Run stringer bead and joints with filler in horizontal position.*

d. Run stringer bead and joints with filler in vertical position.*

e. Run stringer bead and joints with filler in overhead position.*

*Competency listed on competency profile

MODULE: OXY-FUEL CUTTING/WELDING

UNIT II: OXYACETYLENE WELDING

CONTENTS OF THIS UNIT

A. Unit objectives

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: EQUIPMENT AND FLAME ADJUSTMENT

   a. Information outline

   b. Handouts

      HO 1.1: Oxyacetylene fusion welding flames
      HO 1.2: Welding tip data
      HO 1.3: Gas welding rod data

   c. Assignment sheet

      AS 1.1: Equipment and flame adjustment

   d. Answers to assignment sheet

2. Lesson 2: WELDING TECHNIQUES

   a. Information outline

   b. Assignment sheet

      AS 2.1: Welding techniques

   c. Answers to assignment sheet

   d. Job sheets

      JS 2.1: Set-up
      JS 2.2: Run stringer bead without filler metal
      JS 2.3: Run stringer bead and joints with filler in flat position
      JS 2.4: Run stringer bead and joints with filler in horizontal position
      JS 2.5: Run stringer bead and joints with filler in vertical position
      JS 2.6: Run stringer bead and joints with filler in overhead position

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Operator's Manual for Oxy-Fuel Gas Cutting. Miami: American Welding Society, 1978.

2. Instruction Manual, Welding and Cutting, and Lead-Burning. St. Louis: Modern Engineering Company, Inc., 1970.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Oxy-acetylene Welding and Cutting. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Demonstrate all procedures for the oxy-fuel welding process and emphasize the safety aspects of each part of the procedure.

2. Use JS 2.1 as a set-up checklist for the job sheets in this unit.

3. Invite a representative from a local or area gas welding supply company talk to the students about welding gases, cylinders, gas uses, and safe handling of gases.

4. Ask manufacturer's representatives from local or area welding supply companies to demonstrate the safe use of oxy-fuel equipment to the students. Students can discuss types of equipment that are shown.

5. Have a work place available to demonstrate good and bad welds, to show proper and improper braze welding, and to discuss flux and its uses in oxy-fuel welding.

B. Suggested student activities

1. Arrange a tour of a local or area welding supply house so students can get a first-hand look at oxyacetylene equipment and materials.

C. Suggested supplemental audiovisuals from The Media Center, State Fair Community College, Sedalia, Mo.

1. Setting Oxyacetylene Equipment and Lighting Torch (W-80-115). 1980.

2. Oxyacetylene Welding in Flat Position--Part I (W-80-116). 1980.

3. Oxyacetylene Welding in Flat Position--Part II (W-80-117). 1980.

4. Welding Cast Iron (W-88-300). 1988.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT II: OXYACETYLENE WELDING

LESSON 1: EQUIPMENT AND FLAME ADJUSTMENT

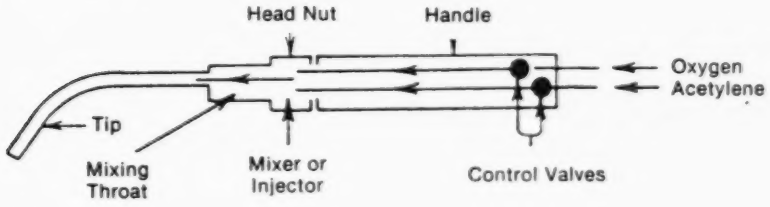
I. Welding torch and mixer components

A. Parts and functions of a welding torch

1. Torch handle: the basic body of the torch that contains valves to control the flow of oxygen and acetylene

2. Welding head or tip: that welding torch component that contains mixer or injector, the mixing throat and the welding head or tip

NOTE: A torch handle can also be rigged for cutting. In that case, the component is referred to as a cutting nozzle or tip.



B. Mixer types and purposes

1. Medium or equal-pressure type: supplies oxygen and acetylene at approximately equal pressures and is usually more fuel efficient

2. Injector type: supplies oxygen at a relatively high pressure and acetylene at a relatively low pressure and can maintain normal pressures even when there are oxygen fluctuations that sometimes occur in plant piping systems

II. Oxyacetylene flame types and characteristics (HO 1.1)

A. Oxidizing

1. Characteristics--excess oxygen to acetylene burning ratio with no acetylene feather; makes a harsh, hissing sound

2. Uses--least used because it oxidizes metal; used for braze welding with a bronze rod

B. Neutral

1. Characteristics--burns equal amounts of oxygen and acetylene, and has a clear, clean-edged inner cone

2. Uses--the most used flame for OAW applications

C. Reducing (X to 2X, lightly carburizing)

1. Characteristics--burns slightly more acetylene than oxygen; acetylene feather appears just beyond the point of the neutral flame; is also a carburizing flame

2. Uses--backhand welding and for welding mild steel with low-alloy rods

D. Carburizing (2X to 3X)

1. Characteristics--excess acetylene-to-oxygen burning ratio with an acetylene feather 2-3 times the length of the inner cone

2. Uses--some hardfacing, but must be used selectively because it adds carbon to base metals

III. Guidelines for flame adjustment

A. To secure a neutral flame, always start with an excess of acetylene, then increase the flow of oxygen or decrease the flow of acetylene until the acetylene feather disappears from the center cone.

B. An excess of acetylene is easy to spot, but an excess of oxygen is difficult to spot. It will cause molten metal to spark excessively.

C. Make sure regulators working pressures are those recommended for the tip size you are using.

D. Beginning welders should not use the harshest flame that the welding torch can produce. Use a larger tip if more heat is needed.

IV. Torch operation problems and causes

A. Backfire: a momentary backing of the flame into the welding tip, usually accompanied by a loud "pop"

CAUTION: Repeated backfire indicates the potential for greater problems, and the equipment should be shut down and serviced.

B. Flashback: a continued burning back of the flame into the tip, mixer or torch body, usually accompanied by a loud hiss or squeal

CAUTION: When flashback occurs, immediately shut off the oxygen torch valve, then the acetylene torch valve, and then shut the system down completely and check for damage. Always remember that a loud hiss or squealing sound indicates immediate danger and a need for immediate shut-down.

C. Causes of backfire and flashback

1. Dirty seating surfaces
2. Failure to purge equipment
3. Leaks from loose tips or tip nuts
4. Incorrect gas pressures
5. Insufficient volume of oxygen or acetylene
6. Using tip too close to work or touching work with tip
7. Using tip in confined area
8. Overheating tip

V. Welding tip selection and its relation to other welding elements (HO 1.2)

A. Welding tip sizes should be selected according to the thickness of the metal to be welded and the type of fuel gas to be used.

B. Drill size listed with a tip indicates the size of the orifice when new so the correct size tip cleaner can be selected and the orifice can be properly checked for wear.

NOTE: When using a tip cleaner on an orifice, select a cleaning probe slightly smaller than the orifice. Never force an oversized probe into an orifice. Work up to a proper size.

C. Tip manufacturer's recommended regulator pressures for fuel gases should not exceed the minimum or maximum recommended for a specific size tip.

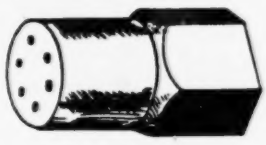
D. For gases other than acetylene, tip size and regulator pressures recommended by the manufacturer should be carefully followed.

E. Gas consumption data on tip selection charts are for estimating purposes, and the actual consumption will vary with the material being welded and the operator's skill.

F. Gas pressure recommendations on tip data charts are usually based on a hose length of 25 feet. Longer lengths of hose should have about 3 PSI added per each additional 25 feet.

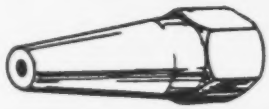
VI. Special purpose tips and uses

A. Oxygen-acetylene heating tip: multi-flame tip for light preheating, commonly called a "rosebud"



B. Oxygen-natural gas or propane heating tip: multi-flame tip for heating. The recessed flame ports make it an excellent tip for silver brazing or soft soldering

C. Oxygen-acetylene welding tip: long cone flame characteristics for welding, brazing and silver brazing



D. Oxygen-natural gas or propane brazing tip: long cone flame characteristics for brazing and silver brazing

VII. Filler rod selection, handling and safety (HO 1.3)

A. Select rod that has the same or similar properties of the base metal

B. Select rod that is the correct size for the thickness of the metal being welded

NOTE: The general rule is that the rod should have a diameter equal to the metal being welded, but because standard rod diameters go only to 1/4", adjustments in weld design are required for certain applications.

C. Keep rods properly labeled and stored in a clean, dry place

D. Keep hot filler rods away from combustible materials

E. Bend the end of the filler rod to prevent eye injuries

NOTE: This is especially a good rule for beginners in a school-shop situation. Sometimes instructors have students cut the filler rods in half to minimize problems.

VIII. Additional guidelines

A. AWS designations for iron and steel gas welding rods

1. Rods are identified with a two-letter, two-digit designation such as RG65.

2. The "R" indicates a rod, while the "G" indicates use with gas welding. The "65" indicates tensile strength in thousands of pounds per square inch or a 65,000 pounds per square inch tensile strength.

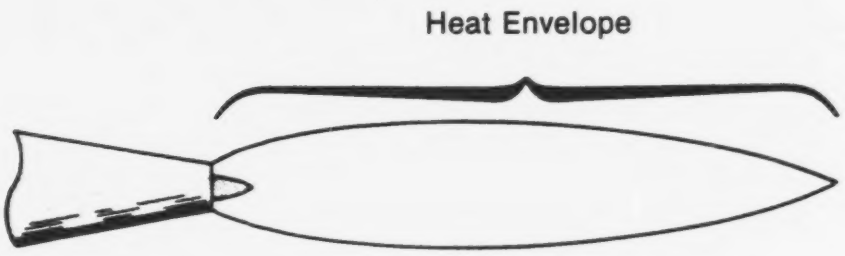
B. Flux selection, handling and safety

1. Flux selection will always depend on the type of metal being welded, weld design and specifications.

2. Flux will normally be used to weld cast iron, for braze welding stainless steel and cast iron, for copper and aluminum and their alloys, and for magnesium alloys.

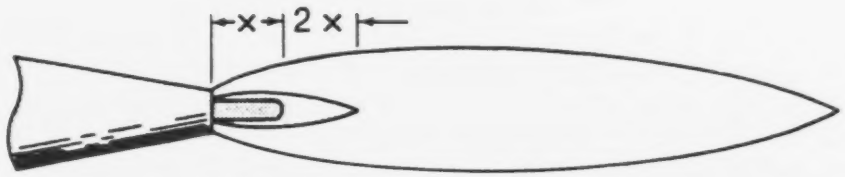
3. After use, the lid on a tin of flux should be securely resealed before storing.

OXYACETYLENE FUSION WELDING FLAMES

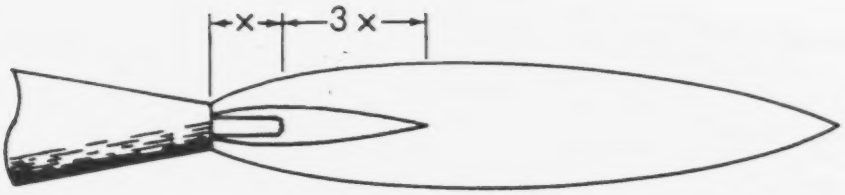


Oxidizing Flame

Neutral Flame



Reducing Flame



Carburizing Flame

WELDING TIP DATA

Metal Thickness	Tip Size	Drill Size	Oxygen Pressure P.S.I.G.		Acetylene Pressure P.S.I.G.		Acetylene Consumption SCFH*	
			Min.	Max.	Min.	Max.	Min.	Max.
Up to 1/32"	000	75	3	5	3	5	3/4	1 1/2
1/64" - 3/64"	00	70	3	5	3	5	1 1/2	2 1/2
1/32" - 5/64"	0	65	3	5	3	5	2 1/2	4
3/64" - 3/32"	1	60	3	5	3	5	4	6
1/16" - 1/8"	2	56	3	5	3	5	6	10
1/8" - 3/16"	3	53	4	7	3	6	9	18
3/16" - 1/4"	4	49	5	10	4	7	15	28
1/4" - 1/2"	5	43	6	12	5	8	22	40
1/2" - 3/4"	6	36	7	14	6	9	30	52
3/4" - 1 1/4"	7	30	8	16	7	10	38	66
1 1/4" - 2"	8	29	10	19	8	12	48	82
2" - 2 1/2"	9	28	12	22	9	14	58	100
2 1/2" - 3"	10	27	14	24	10	14	70	118
3" - 3 1/2"	11	26	16	26	11	15	84	138
3 1/2" - 4"	12	25	18	28	12	15	100	160

*Oxygen consumption is 1.1 times the acetylene under neutral flame conditions.

Gas consumption data is merely for rough estimating purposes. It will vary greatly on the material being welded and the particular skill of the operator.

Pressures are approximate for hose length up to 25 ft. Increase for longer hose lengths about 3 psi per 25 feet.

EQUIPMENT AND FLAME ADJUSTMENT

Complete the following chart listing types and characteristics of oxyacetylene flames.

Name	Characteristics	Uses
1.	Excess oxygen-to-acetylene burning ratio with no acetylene feather; makes a harsh, hissing sound	Least used because it oxidizes metal; is used for braze welding with a bronze rod
2.	Burns equal amounts of oxygen and acetylene; has a clear, clean-edged inner cone	The most used flame for OAW applications
3.	Burns slightly more acetylene than oxygen; acetylene feather appears just beyond the point of the neutral flame; is also a carburizing flame	Used for backhand welding and for welding mild steel with low-alloy rods
4.	Excess acetylene-to-oxygen burning ratio with an acetylene feather 2-3 times the inner cone length	Used for some hardfacing, but must be used selectively because it adds carbon to base metals

Distinguish between true and false statements by placing a T before those which are true and an F before those which are false.

____ 5. To secure a neutral flame, always start with an excess of acetylene, then increase the flow of oxygen or decrease the flow of acetylene until the acetylene feather disappears from the center cone.

____ 6. An excess of acetylene is easy to spot, but an excess of oxygen is difficult to spot. It will cause molten metal to spark excessively.

____ 7. Make sure regulator working pressures are those recommended for the tip size being used.

____ 8. Beginning welders should use the harshest flame that the welding torch can produce.

____ 9. Cut back flame length slightly when a flame is too harsh.

____ 10. Welding tip sizes should be selected only according to the thickness of the metal to be welded.

____ 11. Drill size listed with a tip indicates the size of the orifice when new so the correct size tip cleaner can be selected and the orifice can be properly checked for wear.

___ 12. Tip manufacturer's recommend regulator pressures or fuel gases are only suggestions and don't really mean much.

___ 13. For gases other than acetylene, tip size and regulator pressures recommended by the manufacturer should be carefully followed.

___ 14. Gas consumption data on tip selection charts are for estimating purposes, and the actual consumption will vary with the material being welded and the operator's skill.

___ 15. Gas pressure recommendations on tip data charts are usually based on a hose length of 25 feet. Longer lengths of hose should have about 3 PSI added per each additional 25 feet.

___ 16. Select a rod that has the same or similar properties of the base metal.

___ 17. Select a rod that is the correct size for the thickness of the metal being welded

___ 18. Keep rods properly labeled and stored in a clean, dry place.

___ 19. Keep hot filler rods away from combustible materials.

___ 20. Bend the end of the filler rod to prevent eye injuries.

___ 21. After use, the lid on a tin of flux should be discarded.

ANSWERS TO ASSIGNMENT SHEET 1.1

1. Oxidizing
2. Neutral or X
3. Reducing X to 2X
4. Carburizing 2X to 3X
5. T
6. T
7. T
8. F
9. T
10. F
11. T
12. F
13. T
14. T
15. T
16. T
17. T
18. T
19. T
20. T
21. F

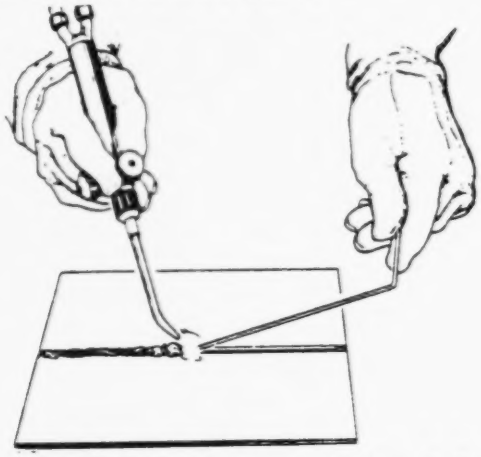
MODULE: OXY-FUEL CUTTING/WELDING

UNIT II: OXYACETYLENE WELDING

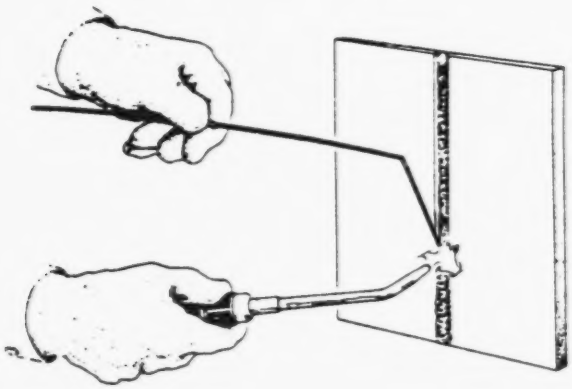
LESSON 2: WELDING TECHNIQUES

I. Welding positions and definitions

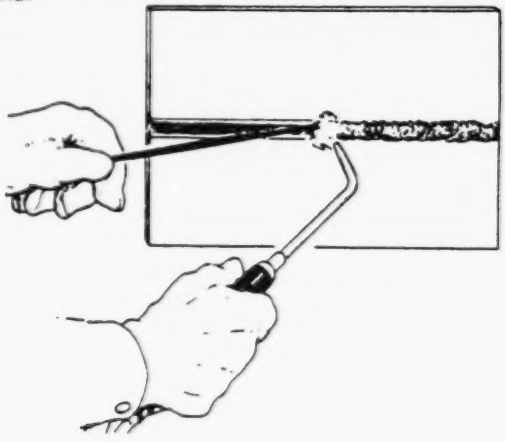
A. Flat: surfaces of the work lie parallel to the ground.



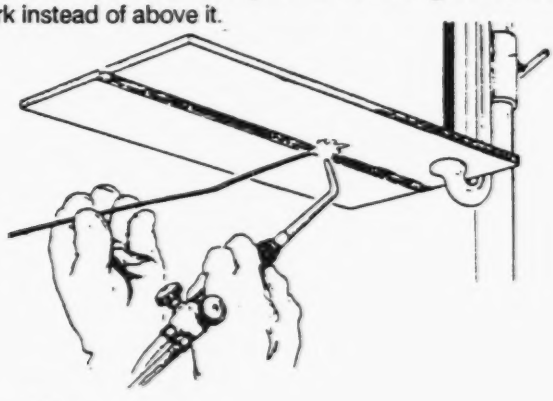
B. Vertical: both the surfaces of the work and the line of the weld are perpendicular to the ground.



C. Horizontal: the surfaces of the work are perpendicular to the ground, but the weld line is parallel to the ground.



D. Overhead: surfaces of the work are parallel to the ground, but welding is performed from below the work instead of above it.



II. Elements of good fusion welding

A. Flame and rod angles: The relative angles of the rod and the flame in relationship to the work affect welding speed and weld quality.

B. Flame-to-work distance: Normally, the tip of the flame's center cone should be kept about 1/8" from the surface of the work or the weld puddle.

NOTE: With skill, welders learn to vary work distance to dig into the puddle, to vary torch angle or to back off for slower welding in difficult positions.

C. Bend in rod: Putting a bend in the rod about 8" from the end will keep your rod hand out of the path of hot air downstream from the flame, provide better vision of the weld area and give better control.

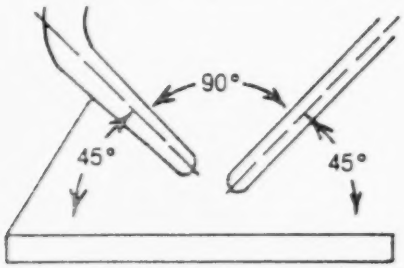
NOTE: To bend a rod, heat it at 8" from the end and force it against the work table or the work itself.

D. Rod freeze: When the rod sticks to the weld, melt it loose with the flame instead of trying to pull it loose.

E. Stub ends: Eliminate the waste of stub ends by saving and welding stub ends together or by welding another rod onto the stub end.

III. Rules of thumb for rod and torch angles

A. The best practice for beginners is to hold both the rod and the torch at 45-degree angles from the surface of the workpiece to create a 90-degree angle between the two.



B. When the torch is held at a 45-degree angle, it not only reduces heat input directly under the tip but also spreads heat ahead of the weld for better control.

C. The flame should always be pointed along the line of the weld and not angled off to one side.

D. The more vertical the angle of the torch flame, the more heat input under the torch tip.

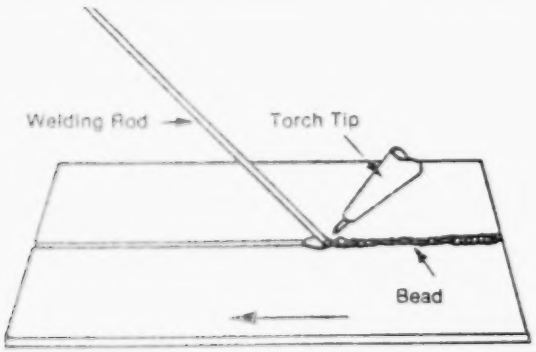
E. With experience, more vertical torch angles are helpful in certain situations, but used improperly, a more vertical torch angle usually results in burning a hole through the base metal.

IV. Characteristics of forehand and backhand techniques

A. Forehand

1. For a right-handed operator, welding proceeds from right to left and from left to right for a left-handed operator.

2. The torch flame is pointed toward the unfinished end of the weld.

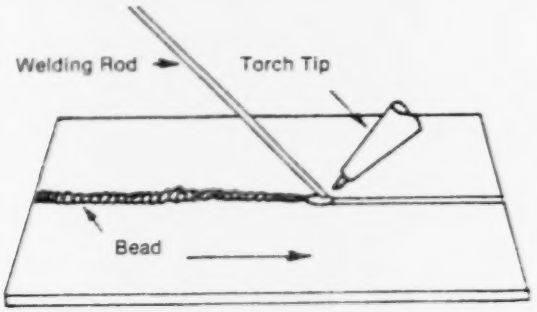


B. Backhand

1. For a right-handed operator, welding proceeds from left to right and from right to left for a left-handed operator.

2. The torch flame is pointed toward the finished end of the weld, and the filler rod is pointed toward the unfinished end of the weld.

3. The backhand technique is useful in some circumstances, but beginners should stick to the forehand technique until they develop skill.



V. Controlling flame and rod motions

A. Keep both the flame and the filler rod in almost constant motion with the flame moving slowly forward across the line of the weld in a back-and-forth motion as the rod moves back and forth from one side of the puddle to the other.

B. Keep rod motion opposite flame motion so that the inner cone of the flame is pointed directly at the rod for only a part of each back-and-forth cycle.

C. When the end of the rod is drawn away from the puddle, don't draw it away very far, but keep it in the outer cone of the flame.

D. Remember that puddle control can also come from the heat of the flame and rod motion because the flame adds heat while the rod takes away heat, so control can be a product of these elements too.

VI. Joint preparation

A. Basic steps

1. Beveling: putting an angle, usually 30 degrees, on pieces of material so that when they are joined, the weld will get good penetration below the surface of the base metal

   NOTE: Bevels may be machined or cut with a saw. The most common method is to use an oxyacetylene cutting torch.

2. Grinding: the use of an abrasive device, usually a portable grinder, to remove metal or slag from the weld area

NOTE: Although grinding can be used to bevel plates, it is mostly used to clean slag off a weld area after cutting or welding.

B. Preheating

1. With the exception of cast iron, preheating, interpass and postheating in oxyacetylene welding are usually accomplished in the welding process.

2. Additional preheating and postheating are usually required with cast iron.

3. An oxyacetylene flame is also used for preheating, interpass and postheating in other welding processes.

VII. Cleanup, inspection and testing

A. After all welds, from first to last, the weld area should be cleaned with a wire brush until the entire weld is completely visible.

B. After cleaning, the weld should be visually inspected to judge if it is acceptable or if its appearance indicates the need for testing.

NOTE: A visual inspection after every pass should be considered part of any welding procedure. Every welder should develop the habit of inspecting welds so that it becomes an automatic reflex.

C. Testing

1. A nondestructive test checks the quality and soundness of a weld without destroying the base metal and the weld itself. (Examples: visual test, x-ray test, magnetic particle test, ultrasonic test)

2. Destructive testing checks the quality and soundness of a weld by destroying the weld itself or the weld and the base metal. (Examples: guided bend test, acid etching test and nick-break test)

NOTE: Beginning welders should become familiar with testing procedures. Your instructor will determine the type or types of testing you should use.

WELDING TECHNIQUES

Select the word(s) which best complete the sentence or answers the question.

___ 1. With the forehand technique in fusion welding, a right-handed operator proceeds from _____ and a left-handed operator welds from ____ .

a. Left to right, left to right
b. Left to right, right to left
c. Right to left, right to left
d. Right to left, left to right

___ 2. With the forehand technique, the torch flame is pointed _____ the _____ end of the weld.

a. Away from, finished
b. Toward, unfinished
c. Away from, unfinished
d. Toward, finished

___ 3. With the backhand technique in fusion welding, a right-handed operator proceeds from _____ and a left-handed operator welds from _____ .

a. Left to right, left to right
b. Left to right, right to left
c. Right to left, right to left
d. Right to left, left to right

___ 4. The torch flame is pointed _____ the finished end of the weld, and the filler rod is pointed _____ of the weld.

a. Toward, toward the unfinished end
b. Toward, toward the finished end
c. Away from, away from the finished end
d. Away from, away from the unfinished end

___ 5. The backhand technique is good in _____ circumstances; beginners should use the _____ technique until they develop skill.

a. All, backhand
b. Most, backhand
c. Some, forehand
d. Rare, forehand

___ 6. Keep both the flame and the filler rod in almost constant _____ motion with the flame moving slowly forward across the line of the weld as the rod moves ____ .

a. Back-and-forth, just ahead of the flame
b. Back-and-forth, from one side of the puddle to the other
c. Straight-line, from one side of the puddle to the other
d. Straight-line, from one end of the weld to the other

___ 7. Keep the motion of the rod _____ the motion of the flame so that the _____ cone of the flame is pointed directly at the rod for only a part of each back-and-forth cycle.

a. Beside, inner
b. Beside, outer
c. Away from, outer
d. Opposite, inner

___ 8. Heat from the flame and rod motion contribute to puddle control because the flame _____ heat and the rod _____ heat.

a. Decreases, also decreases
b. Adds, also adds
c. Adds, takes away
d. Takes away, adds

___ 9. Beveling is the application of an angle, usually _____ degree, on pieces of material so that when they are joined the weld will get good penetration below the surface of the base metal.

a. 60
b. 45
c. 30
d. 15

___ 10. With the exception of _____, preheating, interpass and postheating are usually accomplished in the welding process.

a. Steel
b. Cast iron
c. Zinc alloys
d. Magnesium alloys

___ 11. Additional _____ are usually required with cast iron.

a. Preheating and interpass
b. Preheating and postheating
c. Interpass and postheating
d. Interpass

___ 12. After all welds, the weld area should be cleaned with a wire brush from the first to the last welded until _____ weld is _____.

a. The entire, completely visible
b. Most of the, visible
c. Part of the, visible
d. The entire, smooth

___ 13. After cleaning, the weld should be _____ to determine whether it is _____ or if there is a need for further testing.

a. Mechanically inspected, acceptable
b. Destructively tested, acceptable
c. Visually inspected, unacceptable
d. Visually inspected, acceptable

___ 14. A test that checks the quality and soundness of a weld without destroying the base metal and the weld itself is _____, while a test that checks the quality and soundness of a weld by destroying it is _____ .

a. Called nondestructive testing, destructive testing
b. Called destructive testing, nondestructive testing
c. A shortcut, a thorough test
d. A visual test, a mechanical test

___ 15. The best practice for beginners is to hold both the rod and the torch at _____ from the surface of the workpiece to create a _____ between the two.

a. 90-degree angles, 180-degree angle
b. 35-degree angles, 70-degree angle
c. 45-degree angles, 90-degree angle
d. 60-degree angles, 120-degree angle

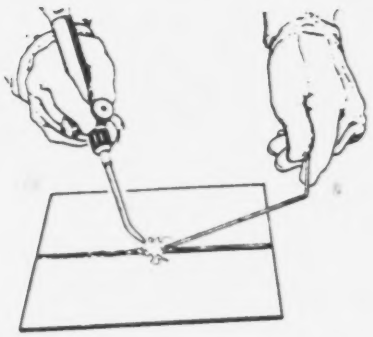
___ 16. When the torch is held at a _____ angle, it not only _____ heat input directly under the tip, but also spreads heat ahead of the welder for better control.

a. 35-degree, reduces
b. 45-degree, reduces
c. 45-degree, increases
d. 90-degree, reduces

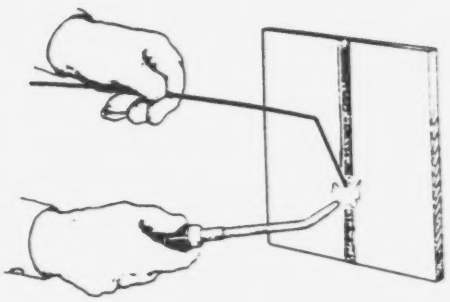
___ 17. With experience, more _____ torch angles are helpful in certain situations; used improperly, this angle usually results in ____ the base metal.

a. Angled, burning a hole through
b. Angled, scorching
c. Vertical, burning a hole through
d. Horizontal, scorching

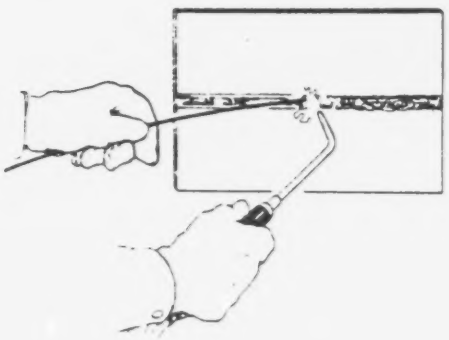
Identify the following welding positions by writing the correct position name below each illustration.



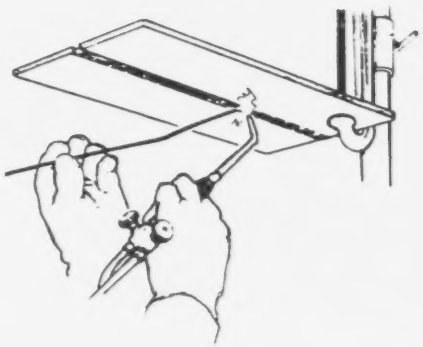
18. _____



19. _____



20. _____



21. _____

ANSWERS TO ASSIGNMENT SHEET 2.1

1. d
2. b
3. b
4. a
5. c
6. b
7. d
8. c
9. c
10. b
11. b
12. a
13. d
14. a
15. c
16. b
17. c
18. Flat
19. Vertical
20. Horizontal
21. Overhead

SET-UP

Equipment:

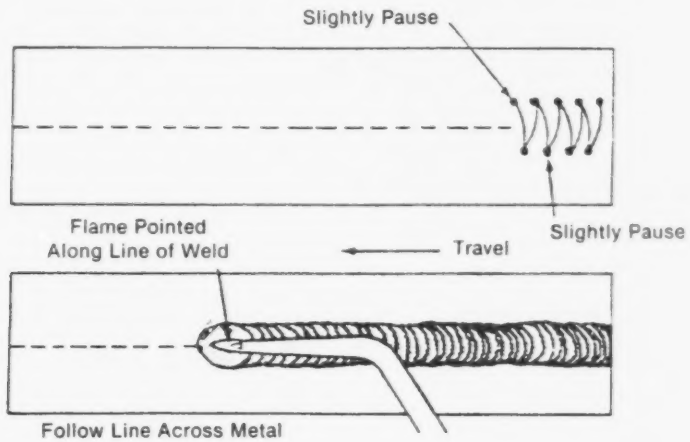
Oxyacetylene welding unit with assorted welding tips
Welding gloves
Welding goggles, shade #4 or #5 lens
Pliers
Spark lighter
Mild steel coupons as selected by instructor
Personal safety equipment and clothing

Procedure:	Evaluation 3 2 1 N
1. Secure the equipment and materials as specified above. Obtain job sheet from instructor.	— — — —
2. Check work area to make sure it is free of flammable materials and is well ventilated. Secure workpiece.	— — — —
3. Check thickness of workpiece and select proper tip. Place and tighten tip onto the welding torch.	— — — —
4. Determine regulator pressures required, set up and purge regulators and lines.	— — — —
5. Put on gloves and goggles. Light torch and adjust to a neutral flame according to safety standards previously outlined. Hold the torch comfortably with either hand and use the forehand welding technique when performing these job sheets.	— — — —
Average of above evaluations*	— — — —

*This average must meet a specified score before advancing to the next job sheets.

RUN STRINGER BEAD WITHOUT FILLER METAL

Procedure:	Evaluation 3 2 1 N
1. Perform JS#1.	— — — —
2. Hold the torch comfortably with either hand and use the forehand welding technique. Move the torch down until the inner cone of the flame is about 1/8" from the surface of the metal and hold it there until a small pool of molten metal forms.	— — — —
3. Move the flame back and forth in a series of short arcs or semi-circles while you advance the puddle as steadily as possible across the plate.	— — — —



4. Keep puddle oval-shaped and bead as straight as possible as you continue forming the bead. NOTE: A thin puddle or bead indicates welding speed is too quick. A large, round puddle that tends to spark indicates welding speed is too slow or that the tip is too close to the workpiece.	— — — —
5. Begin compensating for heat build-up after finishing the first two-thirds of the weld by increasing welding speed slightly and as the weld puddle indicates.	— — — —
6. Stop before reaching the end of the weld so molten metal will not drip off the end of the plate.	— — — —
7. Leave about 1/2" between welds and continue this procedure. Observe puddle shape in relation to torch movement at all times. Practice making the slight adjustments required in welding speed to maintain a puddle approximately 3/8" in diameter.	— — — —

NOTE: Most beginners are tense at this point. Relax and concentrate on the manipulation of the torch and the formation of a well-shaped puddle.

8. After completing several welds, stop and ask your instructor to check your work. — — — —

9. Continue performing these procedures until the instructor indicates you have reached mastery, then advance to the next job sheet. — — — —

10. Complete final weld and shut off torch. Shut down equipment according to safety standards previously outlined in Unit I. — — — —

Average of above evaluations* — — — —

*This average is the student's final evaluation for competency C10: Run stringer bead without filler metal.

RUN STRINGER BEAD AND JOINTS WITH FILLER IN FLAT POSITION

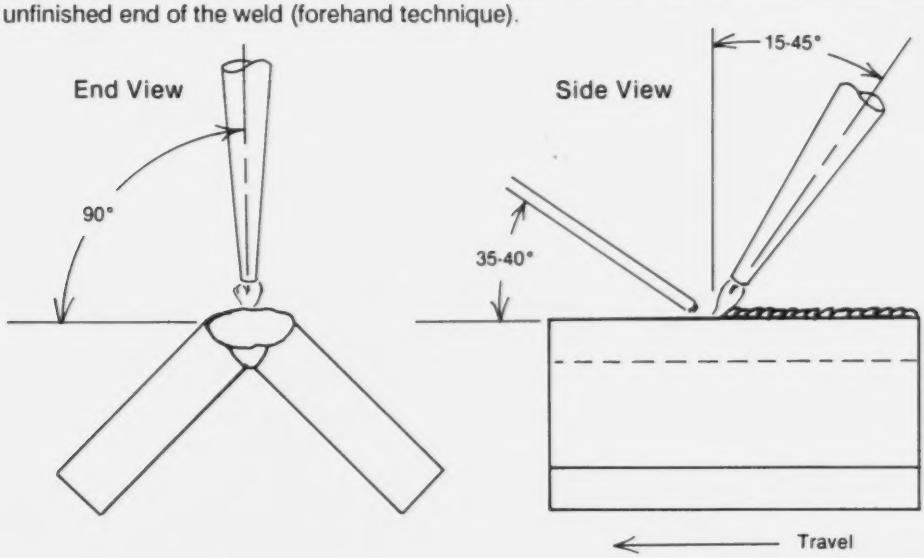
NOTE: This job sheet should be used for steps of procedure and to evaluate the construction of various joints in the flat position. Students should practice laying beads and then weld as many joints in the flat position as the instructor deems necessary. Joints include outside corner, butt, lap and T.

Procedure:

1. Perform JS#1.

2. Check joint to make sure it is properly prepared and properly fitted.

3. Tack weld joint at each end. Position torch and rod so that the torch flame points toward the unfinished end of the weld (forehand technique).



4. Move the torch down until the inner cone of the flame is about 1/8" from the surface of the metal. Hold it there until a small pool of molten metal forms, then begin a slight circular movement with the torch.

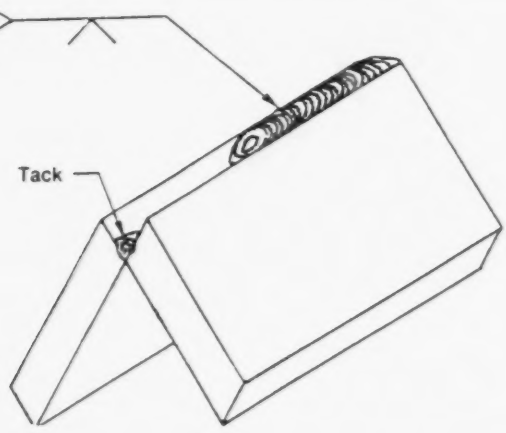
5. Move rod into the center of the puddle at the point of the inner cone. Do not melt the rod with the flame. Allow the heat of the base metal to melt the rod.

6. Withdraw the rod about 1/2" to 3/4" from the inner cone so that the torch can be moved forward.

7. Continue to advance the puddle forward with a slight circular motion of the torch and reinsert the rod into the center of the puddle at the point of the inner cone. Let a drop or two of molten metal fill the puddle as you move the rod in a circular motion.

8. Withdraw the rod. Advance the torch in a circular motion so that a continuous oval-shaped puddle is formed. Then, reinsert the rod as before and continue the technique until the weld is complete.

NOTE: In the following illustration, the AWS welding symbol for this joint has been added so you can become used to associating welding symbols with the welds they represent.



NOTE: The instructor may direct you to change hands at any point in this activity to help improve your manipulative skills.

9. Inspect weld visually for defects. Test weld as directed by instructor.

10. Ask instructor to check your work.

11. As directed by the instructor, prepare work area for next job sheet or check in tools and materials and complete shut-down of equipment according to safety standards in Unit I.

Visual inspection of product:	Evaluation 3 2 1 N
1. Uniform in width, chill rings, etc.	— — — —
2. No defects, such as undercut or cold lap	— — — —
3. Straightness of weld	— — — —
4. Obvious penetration	— — — —
Average of above evaluations*	— — — —

*This average is the student's final evaluation for competency C11: Run stringer bead and joints with filler metal in flat position.

RUN STRINGER BEAD AND JOINTS WITH FILLER IN HORIZONTAL POSITION

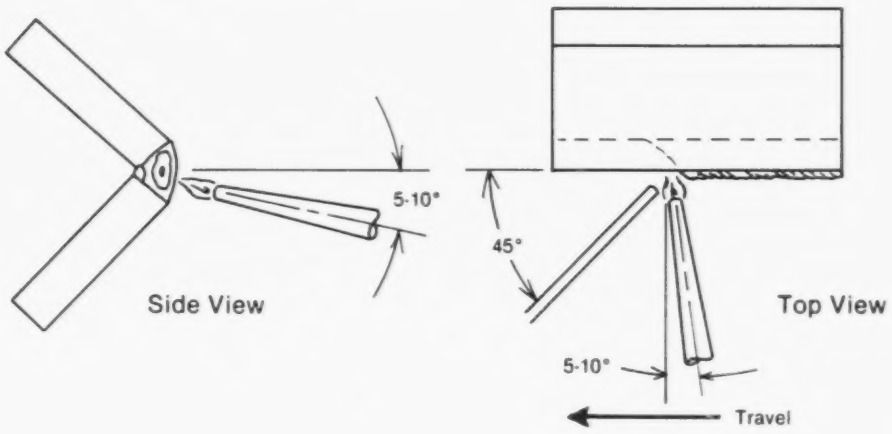
NOTE: This job sheet should be used for steps of procedure and to evaluate the construction of various joints in the horizontal position. Students should practice laying beads and then weld as many joints in the horizontal position as the instructor deems necessary. Joints include outside corner, butt, lap and T.

Procedure:

1. Perform JS#1.

2. Check joint to make sure it is properly prepared and properly fitted.

3. Tack weld joint at each end. Position torch and rod so that the torch flame points toward the unfinished end of the weld (forehand technique).



4. Move the torch down until the inner cone of the flame is about 1/8" from the surface of the metal. Hold it there until a small pool of molten metal forms, then begin a slight circular movement with the torch.

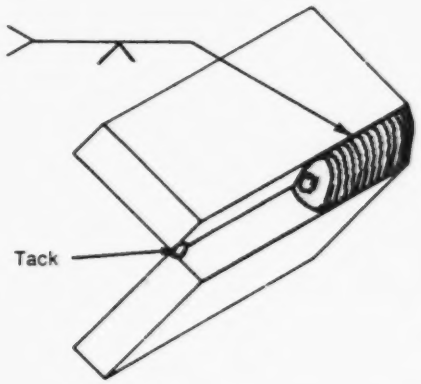
5. Move rod into the center of the puddle at the point of the inner cone. Do not melt the rod with the flame. Allow the heat of the base metal to melt the rod.

6. Withdraw the rod about 1/2" to 3/4" from the inner cone so that the torch can be moved forward.

7. Continue to advance the puddle forward with a slight circular motion of the torch and reinsert the rod into the center of the puddle at the point of the inner cone. Let a drop or two of molten metal fill the puddle as you move the rod in a circular motion.

8. Withdraw the rod. Advance the torch in a circular motion so that a continuous oval-shaped puddle is formed. Then, reinsert the rod as before and continue the technique until the weld is complete.

NOTE: In the following illustration, the AWS welding symbol for this joint has been added so you can become used to associating welding symbols with the welds they represent.



NOTE: Your instructor may direct you to change hands at any point in this activity to help improve your manipulative skills.

9. Inspect weld visually for defects. Test weld as directed by instructor.

10. Ask instructor to check your work.

11. As directed by the instructor, prepare work area for next job sheet or check in tools and materials and complete shut-down of equipment according to safety standards in Unit I.

Visual inspection of product:	Evaluation 3 2 1 N
1. Uniform in width, chill rings, etc.	— — — —
2. No defects, such as undercut or cold lap	— — — —
3. Straightness of weld	— — — —
4. Obvious penetration	— — — —
Average of above evaluations*	— — — —

*This average is the student's final evaluation for competency C12: Run stringer bead and joints with filler metal in horizontal position.

RUN STRINGER BEAD AND JOINTS WITH FILLER IN VERTICAL POSITION

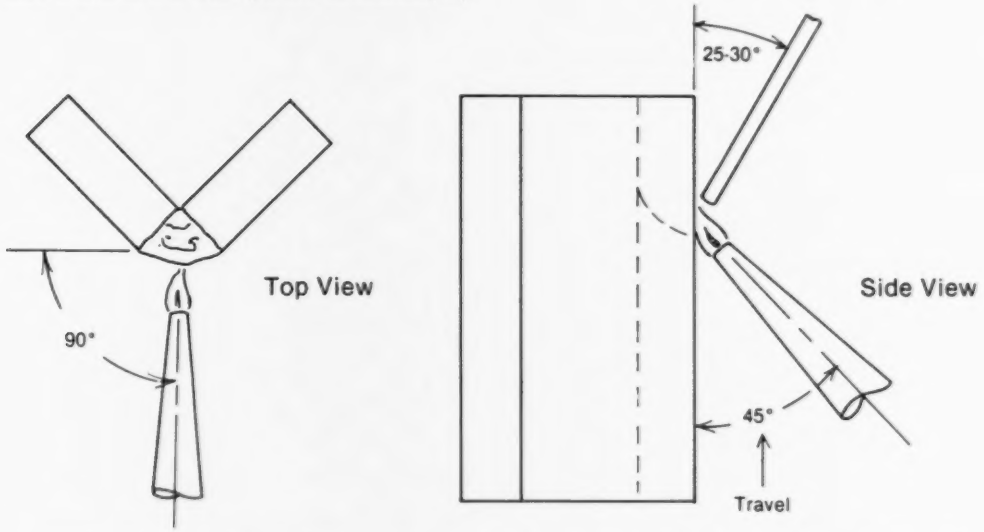
NOTE: This job sheet should be used for steps of procedure and to evaluate the construction of various joints in the vertical position. Students should practice laying beads and then weld as many joints in the vertical position as the instructor deems necessary. Joints may include outside corner, butt, lap and T.

Procedure:

1. Perform JS#1.

2. Check joint to make sure it is properly prepared and properly fitted.

3. Tack weld joint at each end. Position torch and rod so that the torch flame points toward the unfinished end of the weld (forehand technique).



4. Move the torch down until the inner cone of the flame is about 1/8" from the surface of the metal. Hold it there until a small pool of molten metal forms, then begin a slight circular movement with the torch.

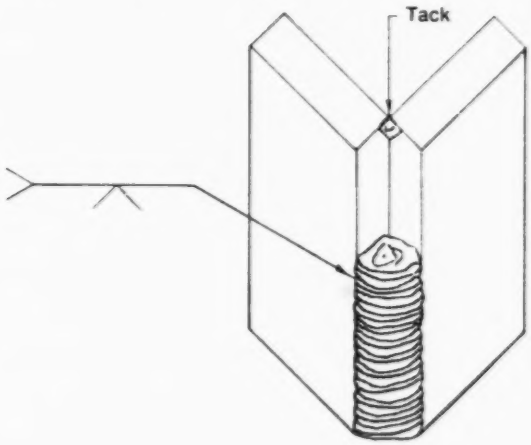
5. Move rod into the center of the puddle at the point of the inner cone. Do not melt the rod with the flame. Allow the heat of the base metal to melt the rod.

6. Withdraw the rod about 1/2" to 3/4" from the inner cone so that the torch can be moved forward.

7. Continue to advance the puddle forward with a slight circular motion of the torch and reinsert the rod into the center of the puddle at the point of the inner cone. Let a drop or two of molten metal fill the puddle as you move the rod in a circular motion.

8. Withdraw the rod. Advance the torch in a circular motion so that a continuous oval-shaped puddle is formed. Then, reinsert the rod as before and continue the technique until the weld is complete.

NOTE: In the following illustration, the AWS welding symbol for this joint has been added so you can become used to associating welding symbols with the welds they represent.



NOTE: Your instructor may direct you to change hands at any point in this activity to help improve your manipulative skills.

9. Inspect weld visually for defects. Test weld as directed by instructor.

10. Ask instructor to check your work.

11. As directed by the instructor, prepare work area for next job sheet or check in tools and materials and complete shut-down of equipment according to safety standards in Unit I.

Visual inspection of product:	Evaluation 3 2 1 N
1. Uniform in width, chill rings, etc.	— — — —
2. No defects, such as undercut or cold lap	— — — —
3. Straightness of weld	— — — —
4. Obvious penetration	— — — —
Average of above evaluations*	— — — —

*This average is the student's final evaluation for competency C13: Run stringer bead and joints with filler metal in vertical position.

RUN STRINGER BEAD AND JOINTS WITH FILLER IN OVERHEAD POSITION

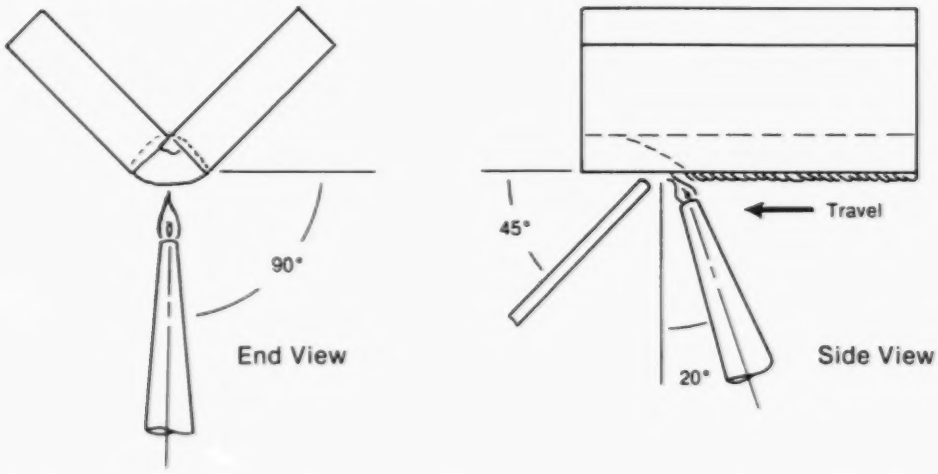
NOTE: This job sheet should be used for steps of procedure and to evaluate the construction of various joints in the overhead position. Students should practice laying beads and then weld as many joints in the overhead position as the instructor deems necessary. Joints may include outside corner, butt, lap and T.

Procedure:

1. Perform JS#1.

2. Check joint to make sure it is properly prepared and properly fitted.

3. Tack weld joint at each end. Position torch and rod so that the torch flame points toward the unfinished end of the weld (forehand technique).



4. Move the torch down until the inner cone of the flame is about 1/8" from the surface of the metal. Hold it there until a small pool of molten metal forms, then begin a slight circular movement with the torch.

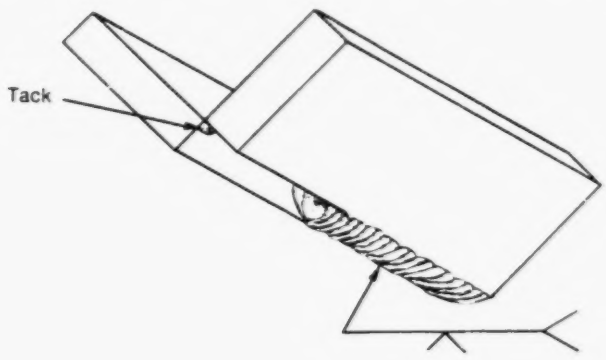
5. Move rod into the center of the puddle at the point of the inner cone. Do not melt the rod with the flame. Allow the heat of the base metal to melt the rod.

6. Withdraw the rod about 1/2" to 3/4" from the inner cone so that the torch can be moved forward.

7. Continue to advance the puddle forward with a slight circular motion of the torch and reinsert the rod into the center of the puddle at the point of the inner cone. Let a drop or two of molten metal fill the puddle as you move the rod in a circular motion.

8. Withdraw the rod. Advance the torch in a circular motion so that a continuous oval-shaped puddle is formed. Then, reinsert the rod as before and continue the technique until the weld is complete.

NOTE: In the following illustration, the AWS welding symbol for this joint has been added so you can become used to associating welding symbols with the welds they represent.



NOTE: Your instructor may direct you to change hands at any point in this activity to help improve your manipulative skills.

9. Inspect weld visually for defects. Test weld as directed by instructor.

10. Ask instructor to check your work.

11. As directed by the instructor, prepare work area for next job sheet or check in tools and materials and complete shut-down of equipment according to safety standards in Unit I.

Visual inspection of product:	Evaluation 3 2 1 N
1. Uniform in width, chill rings, etc.	— — — —
2. No defects, such as undercut or cold lap	— — — —
3. Straightness of weld	— — — —
4. Obvious penetration	— — — —
Average of above evaluations*	— — — —

*This average is the student's final evaluation for competencies C14 and C17.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT II: OXYACETYLENE WELDING

UNIT TEST

Match welding torch parts with functions and special-purpose tips with uses by placing the letter of the best answer in the blank.

____ 1. Part of the torch that contains valves to control the flow of oxygen and acetylene

____ 2. Part of the torch that contains mixer or injector and the mixing throat

____ 3. Multi-flame tip for light pre-heating, commonly called a welding tip "rosebud"

____ 4. Multi-flame tip for heating. Recessed flame ports make it an excellent tip for silver brazing or soft soldering.

____ 5. Long cone flame characteristics for welding, brazing and silver brazing

____ 6. Long cone flame characteristics for brazing and silver brazing

a. Oxygen-acetylene welding tip

b. Oxygen-natural gas or propane brazing tip

c. Welding head/tip

d. Torch handle

e. Oxygen-acetylene heating tip

ab. Oxygen-natural gas

Choose the answer which best completes the statement or answers the question.

____ 7. An injector-type mixer supplies oxygen _____ .

a. And acetylene at approximately equal pressures
b. At a relatively high pressure and acetylene at a relatively low pressure
c. And acetylene but cannot maintain normal pressures when there are oxygen fluctuations
d. None of the above

____ 8. A backfire is a momentary backing of the flame into the welding tip, which is usually accompanied by _____ .

a. A loud hiss
b. Squeaking
c. Squealing
d. A loud pop

____ 9. A flashback is a continued burning back of the flame into the tip, mixer or torch body which is usually accompanied by a loud ____.

a. Soft hissing
b. Squeaking
c. A loud hiss or squeal
d. A loud pop

____ 10. Rods are identified by a _____ designation.

a. Two-letter, one-digit
b. One-letter, two-digit
c. One-letter, one-digit
d. Two-letter, two-digit

____ 11. Backfiring and flashbacks are caused by _____ .
a. Dirty seating surfaces
b. Failure to clean equipment
c. Excess volume of oxygen or acetylene
d. All of the above

____ 12. What type of flame is normally used in oxyacetylene welding?

a. Carburizing
b. Oxidizing
c. Neutral
d. None of the above

____ 13. Which of the following is not a criteria for selecting a welding tip?

a. Type of fuel gas to be used
b. Gas pressure recommendations
c. Gas consumption data
d. Length of the metal to be welded

____ 14. Which is not a proper safety procedure for handling filler rods?

a. Store in a clean, moist place
b. Keep properly labeled
c. Keep hot rods away from combustible materials
d. Bend the end to prevent eye injuries

____ 15. With the forehand technique, the torch flame is pointed _____ the _____ end of the weld.

a. Away from, finished
b. Toward, unfinished
c. Away from, unfinished
d. Toward, finished

____ 16. Beveling is the application of an angle, usually _____, on pieces of material so that when they are joined the weld will get good penetration below the surface of the base metal.

a. 60 degree
b. 45 degree
c. 30 degree
d. 15 degree

____ 17. The best practice for beginners is to hold both the rod and the torch at _____ from the surface of the workpiece to create a _____ between the two.

a. 90-degree angles, 180-degree angle
b. 35-degree angles, 70-degree angle
c. 45-degree angles, 90-degree angle
d. 60-degree angles, 120-degree angle

____ 18. With the backhand technique in fusion welding, a right-handed operator proceeds from _____ and a left-handed operator welds from _____ .

a. Left to right, left to right
b. Left to right, right to left
c. Right to left, right to left
d. Right to left, left to right

____ 19. Keep the rod motion _____ flame motion so that the cone of the flame is pointed _____ at the rod for only a part of each back-and-forth cycle.

a. The same as, directly
b. Opposite, indirectly
c. The same as, indirectly
d. Opposite, directly

____ 20. With the exception of _____, preheating, interpass and postheating are usually accomplished in the welding process.

a. Cast iron
b. Steel
c. Zinc alloys
d. Magnesium alloys

____ 21. After all welds, the weld area should be cleaned with a wire brush from the first to the last welded until _____ weld is _____.

a. The entire, completely visible
b. Most of the, visible
c. Part of the, visible
d. The entire, smooth

____ 22. A test that checks the quality and soundness of a weld without ruining the base metal and the weld itself is _____, while a test that checks the quality and soundness of a weld by destroying it is _____ .

a. Called nondestructive testing, destructive testing
b. Called destructive testing, nondestructive testing
c. A shortcut, a thorough test
d. A visual test, a mechanical test

ANSWERS TO UNIT TEST

1.	d	(C4)	12.	c	(C5)
2.	c	(C4)	13.	d	(C4)
3.	e	(C4)	14.	a	(C1)
4.	ab	(C4)	15.	b	
5.	a	(C4)	16.	c	(C7)
6.	b	(C4)	17.	c	(C4)
7.	b	(C4)	18.	b	
8	d	(C18)	19.	d	
9.	c	(C18)	20.	a	
10.	d	(C4)	21.	a	(C17)
11.	d	(C18)	22.	a	(C17)

MODULE: OXY-FUEL CUTTING/WELDING

UNIT III: OXYACETYLENE CUTTING

UNIT OBJECTIVES

Upon completion of this unit, the student should be able to identify the proper equipment, tip size and flame adjustment to perform free-hand and motorized cuts with the oxyacetylene cutting system. This knowledge will be evidenced by achieving the specified score on the unit test and job sheets.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms with definitions.

1.2 Select true statements concerning oxyacetylene cutting characteristics.

1.3 Identify parts of an oxyacetylene cutting torch.

1.4 Complete statements about cutting-tip design, cleaning, selection and uses.

1.5 Complete statements concerning control of kerf and drag.

1.6 List reasons for poor cuts and elements of a good cut.

1.7 Identify proper working surfaces for oxyacetylene cutting.

1.8 Select true statements concerning manifold system uses with oxyacetylene cutting and welding.

1.9 Identify special safety requirements for oxyacetylene cutting.

2.1 Complete statements concerning technique for cutting straight lines.

2.2 Demonstrate the ability to:

- a. Start up, adjust and shut down cutting equipment.*
- b. Make 90-degree and beveled cuts in mild steel plate.*
- c. Cut a hole in mild steel.*
- d. Lay out and cut pattern on mild steel plate to specifications.*
- e. Set up and cut a pipe bevel by hand.

3.1 Complete statements concerning characteristics and uses of various cutting machines.

3.2 Set up and cut a 30-degree bevel with a tractor-type torch.*

*Addresses competency on profile.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT III: OXYACETYLENE CUTTING

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: CUTTING EQUIPMENT

   a. Information outline

   b. Transparency master

      TM 1.1: Parts of a combination cutting/welding torch

   c. Handout

      HO 1.1: Typical cutting tips and orifices

   d. Assignment sheet

      AS 1.1: Oxyacetylene cutting

2. Lesson 2: HAND CUTTING TECHNIQUE

   a. Information outline

   b. Job sheets

      JS 2.1: Start-up, adjustment and shut-down of equipment
      JS 2.2: Make 90-degree cuts on mild steel plate
      JS 2.3: Make beveled cuts on mild steel plate
      JS 2.4: Cut hole in mild steel
      JS 2.5: Lay out and cut pattern to specifications
      JS 2.6: Set up and cut pipe bevel

3. Lesson 3: MOTORIZED CUTTING TECHNIQUE

   a. Information outline

   b. Assignment sheet

      AS 3.1: Motorized cutting technique

   c. Answers to assignment sheet

d. Job sheet

JS 3.1: Set up and cut 30-degree bevel with tractor-type torch

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Operator's Manual for Oxy-Fuel Gas Cutting. Miami: American Welding Society, 1978.

2. Instruction Manual, Welding and Cutting, and Lead-Burning. St. Louis: Modern Engineering Company, Inc., 1970.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Oxy-acetylene Welding and Cutting. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Invite a manufacturer's representative to demonstrate oxyacetylene cutting techniques to the class. Emphasize safety requirements.

2. Demonstrate the proper use of a tip cleaner.

3. Obtain from a welding manufacturer a cutting chart/poster illustrating proper and improper cuts

MODULE: OXY-FUEL CUTTING/WELDING

UNIT III: OXYACETYLENE CUTTING

LESSON 1: CUTTING EQUIPMENT

I. Terms and definitions

A. Drag line--a condition where the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

B. Kerf--the cut made by a cutting torch

C. Slag--the porous, oxidized residue left after oxyacetylene cutting

II. Characteristics of oxyacetylene cutting

A. Readily portable; can be taken to the worksite

B. Relatively inexpensive when compared to other cutting procedures

C. Can be done quickly and is probably the fastest method of cutting thicker metals or odd shapes

D. Delivers a high-quality cut when properly executed

E. Can be adapted to automatic processes

III. Parts of an oxyacetylene cutting torch (TM 1.1)

A. Oxygen fitting

B. Acetylene fitting

C. Oxygen torch valve

D. Acetylene torch valve

E. Torch body

F. Oxygen cutting lever

G. Oxygen preheat valve

H. Tip nut

I. Slip-in tip

IV. Cutting tips

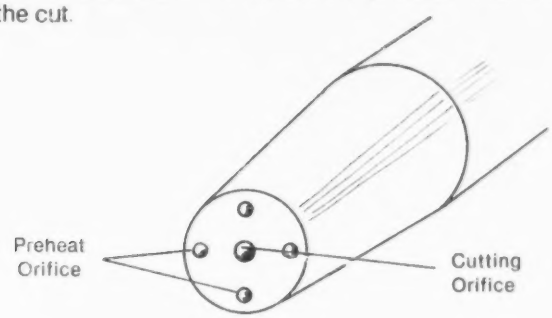
A. Design

1. Cutting tips can be quickly changed so cutting can be adapted quickly to different thicknesses of metal.

2. Cutting tips are designed with two types of orifices--two or more preheat orifices and one oxygen orifice.

3. Preheat orifices provide a mixture of oxygen and acetylene for preheating the metal.

4. The single oxygen orifice directs a pressurized stream of pure oxygen onto the heated metal to accelerate the oxidation process that burns the metal away and completes the cut.



5. Oxyacetylene welding tips are put on finger tight, but some cutting tips have to be tightened with a wrench.

B. Cutting-tip selection (HO 1.1)

1. Determine thickness of material to be cut and use the tip size recommended by the manufacturer.

2. Tip size has a direct relation to gas regulator pressures, and pressures recommended by the manufacturer should always be followed.

3. Tip size affects rate of cutting speed and should be based on the needs of the cutting application.

4. Tip orifice should be compatible with the nature of work and fuel gas used.

C. Cleaning

1. Because cutting tips inevitably pick up slag, they need to be cleaned often.

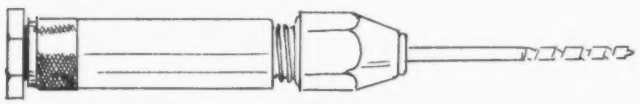
2. The cleaning probe should always be smaller in diameter than the orifice being cleaned. A cleaning probe larger than the orifice should never be forced into the orifice.

3. Do not to break the cleaning probe off inside the orifice.

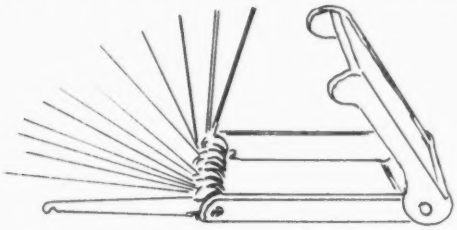
4. Be careful with the seating edges of cutting tips because some of them can be easily damaged.

D. Tip-cleaning tools and uses

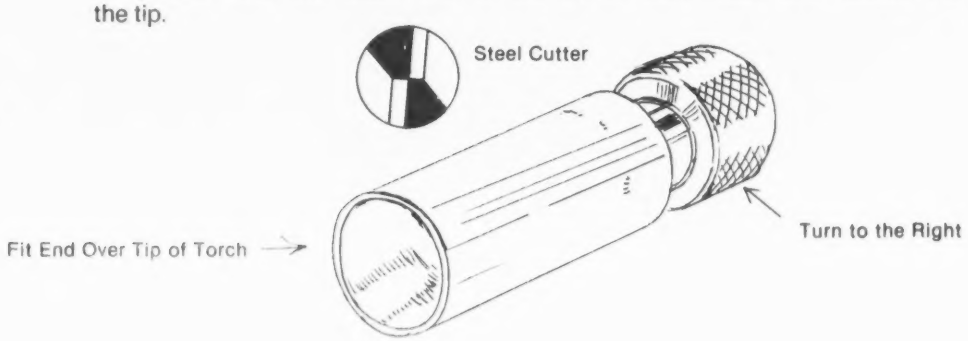
1. Tip drill--used for cleaning and reconditioning orifices



2. Tip cleaner--a device with a series of small file-like probes that are gauged to match specific orifice openings and remove carbon build-up inside the tip



3. Tip nip--a circular-shaped device with small steel cutting blades inset so it can be placed over the entire end of the tip to both clean and restore the face of the tip.



E. Tip use

1. Never use tip as a hammer to chip slag off a cut.

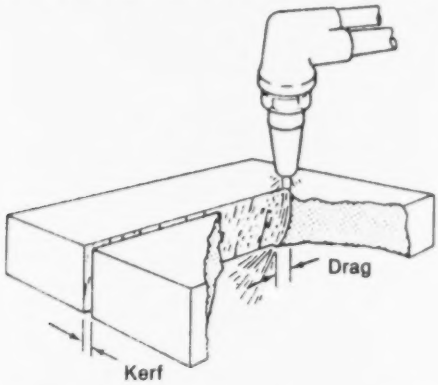
2. Never try to clean tip by rubbing it on fire brick or against anything that is not designed for tip cleaning.

3. Never use an oily or greasy wrench to tighten a cutting tip; never use an oil rag to clean dirt from a tip.

V. Controlling kerf and drag

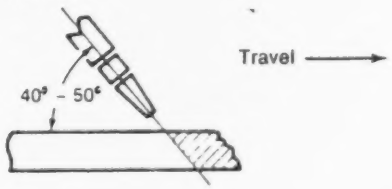
NOTE: For all critical cutting that requires following layout lines, metal should be burned free of oil and grease. Scale and rust should be removed with a wire brush.

A. Good oxyacetylene cutting should produce a clean kerf with minimum drag. This requires proper tip selection, travel speed and fuel gas pressures.

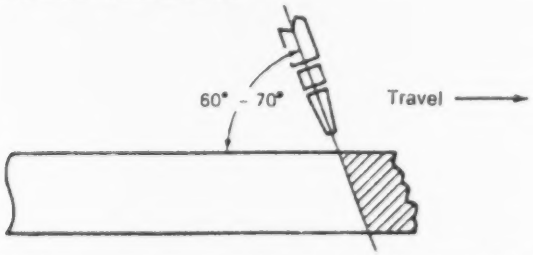


B. While the thickness of metal being cut should dictate tip selection and fuel gas pressures, cutting torch angle is also important.

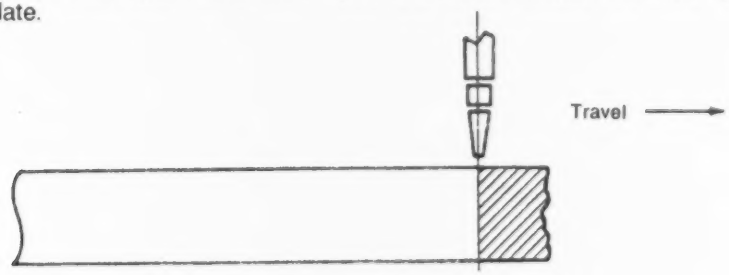
1. For plate thickness 1/4" and less, the torch should be angled about 40-50 degrees from the base metal surface.



2. For plate thickness from 1/4" to 1/2", the torch should be angled about 60-70 degrees from the base metal surface.



3. For plate thickness more than 1/2", the torch should be held perpendicular to the plate.



VI. Good cuts vs. poor cuts

A. Elements of a good cut

1. Square edge

2. Vertical, clean drag lines

3. No adhering slag at bottom edge of the cut

NOTE: The following illustration shows a proper cut made in a steel plate approximately 1" thick and should serve as a reference for comparison with the poor cuts shown later.

B. Major causes of poor oxyacetylene cutting

1. Improper tip selection

2. Speed too slow or too fast

3. Tip and torch angles incorrect

4. Preheat flame too far from workpiece

5. Working pressures incorrectly set

6. Oxygen cutting lever not fully depressed

7. Incorrect flame adjustment

8. Cutting tip orifices clogged with slag or dirt

C. Examples of and reasons for poor cuts

1. Preheat flames were not hot enough for this cut, therefore, the cutting speed was too slow, causing bad gouging at the bottom.

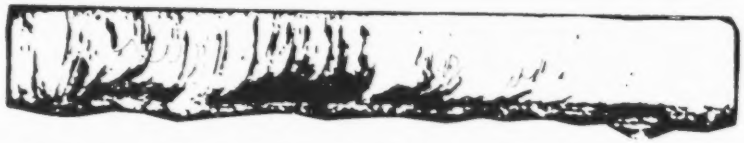
2. Preheat flames were too hot for this cut. The top surface has melted over. The cut edge is irregular, and there is an excessive amount of adhering slag.

3. Oxygen pressure was too low for this cut. The top edge has melted over because of the slow cutting speed.

4. Oxygen pressure was too high and the nozzle size too small. The entire control of the cut has been lost.

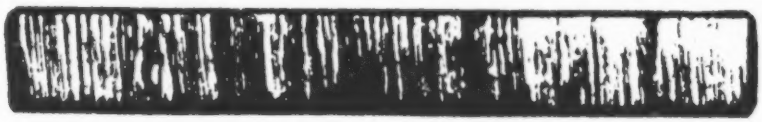
5. Cutting speed was too slow. The irregularities of the draglines are emphasized.

6. Cutting speed was too high. There is a pronounced break to the dragline, and the cut edge is irregular.



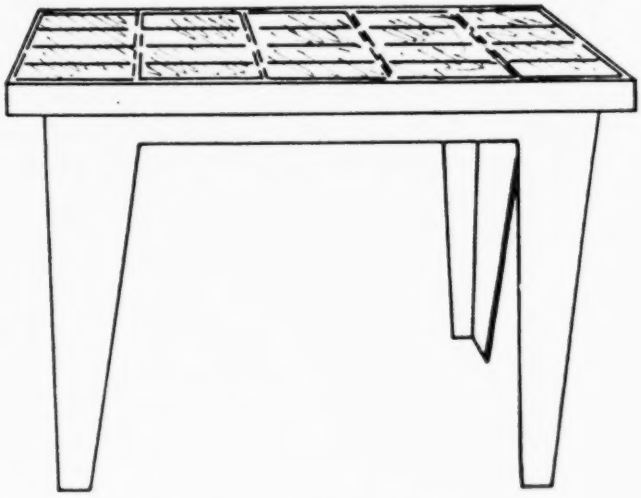
7. Torch travel was unsteady. The cut edge is wavy and irregular.

8. Cut was lost and not carefully restarted. Bad gouges occurred at the restarting point.

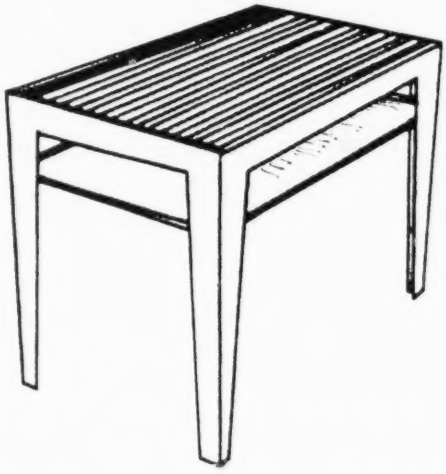


VII. Working surfaces recommended for oxyacetylene cutting

A. Fire brick work table--provides a nonflammable, flame-resistant work area.



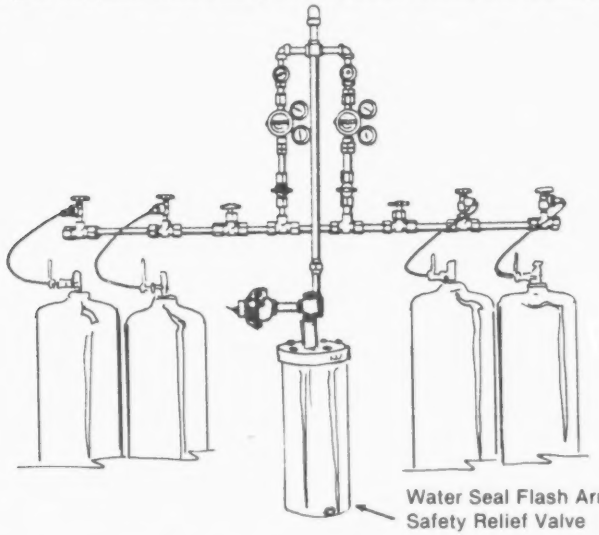
B. Cutting table--a work area with a grated surface that permits slag to drop through into a slag box as cuts are made.



C. Sanded masonry floors--an object too large to fit on a fire brick or cutting table can be put onto sand that has been spread out over a masonry floor.

VIII. Manifold systems and uses

A. Manifolds are systems that pipe fuel gas supplies from two or more tanks to provide continuous gas supplies where only one cylinder would be inadequate.



B. A manifold system should be large enough to supply volume for the largest size tip used.

C. An acetylene manifold should be have a water seal flash arrester.

D. Manifold systems save space when several work stations are required

E. Manifold systems permit the purchase of gases in quantity, which reduces costs and saves money.

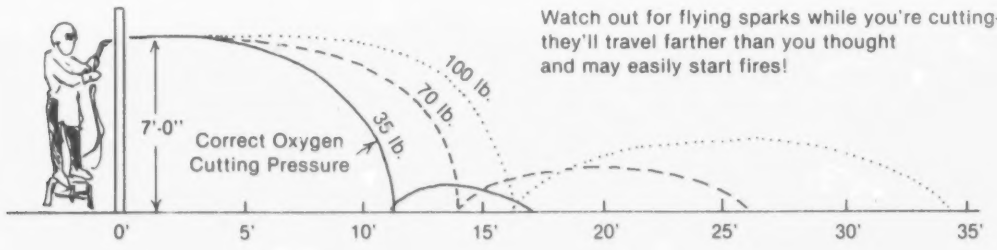
IX. Special safety requirements for oxyacetylene cutting

A. Every rule that applies to the safe use of gases and equipment for oxyacetylene welding applies to oxyacetylene cutting.

B. The use of higher oxygen pressure creates showering sparks that demand shielding screens from nearby areas.

C. Cutting on a masonry floor is even more dangerous than welding on a masonry floor.

D. Since cutting sparks can fly long distances, flammable materials should be moved a safe distance from the cutting area.



E. Oxygen pressure set too high blows sparks much further than needed and wastes oxygen.

F. Do not cut into barrels or any containers because they may still contain the residue of highly explosive materials.

G. Keep cutting as far away from gas cylinders as hose length allows.

H. Never cut toward gas cylinders.

I. Eye protection required for oxyacetylene cutting

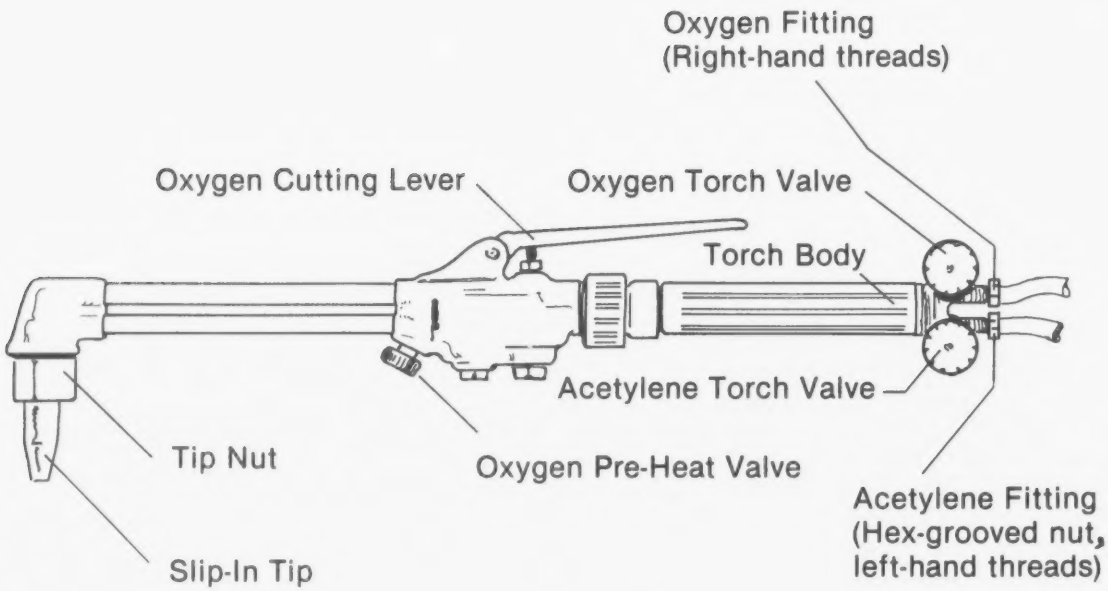
1. Wear safety glasses at all times.

2. Wear safety glasses and a face shield when grinding joints or bevels.

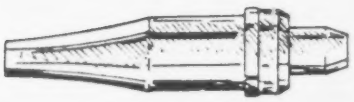
3. Wear welding and cutting goggles to protect eyes from spatter. Choose goggles with a lens shade dark enough to protect eyes from radiation burns.

Type of cutting	Metal thickness	Shade no.
Light	Up to 1"	3 or 4
Medium	1-6"	4 or 5
Heavy	6"+	5 or 6

PARTS OF A COMBINATION CUTTING/WELDING TORCH

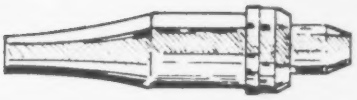


TYPICAL CUTTING TIPS AND ORIFICES



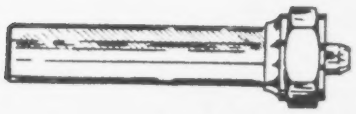
Light Preheat, Light Cutting

Acetylene



Medium Preheat, Light Cutting

Acetylene

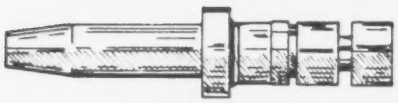


Heavy Preheat, Heavy Cutting

Acetylene

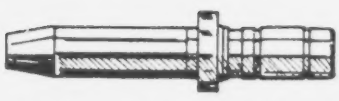
Medium Preheat, Gouging

Acetylene



General Purpose

Propane



General Purpose

Natural Gas (Methane)

OXYACETYLENE CUTTING

Place a T before true statements and an F before false ones.

____ 1. Oxyacetylene cutting units are readily portable and can be taken to the work, as opposed to having to bring the work to the cutting equipment.

____ 2. Oxyacetylene cutting equipment is relatively inexpensive when compared to other cutting procedures.

____ 3. Oxyacetylene cutting can usually be accomplished quickly but is probably the slowest method of cutting thicker metals or odd shapes.

____ 4. Oxyacetylene cutting, when properly executed, delivers a high-quality cut.

____ 5. Oxyacetylene cutting is often done manually but can be adapted to automatic processes.

____ 6. Manifolds are systems that pipe fuel gas supplies from two or more tanks to provide continuous gas supplies where only one cylinder would be inadequate.

____ 7. A manifold system should be large enough to supply volume for the average size tip used.

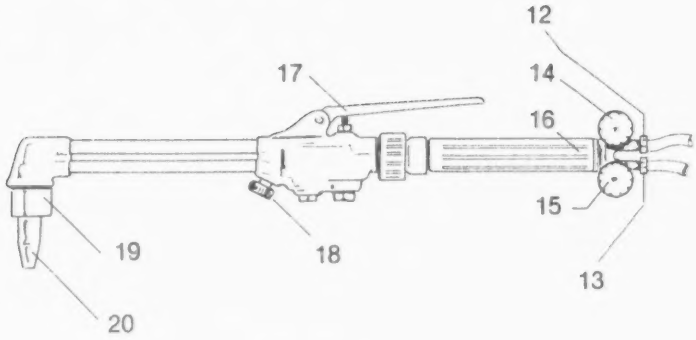
____ 8. An acetylene manifold should be equipped with a water seal flash arrester.

____ 9. Manifold systems save space when a number of work stations are required.

____ 10. Manifold systems permit a school or business to buy gases in quantity, reducing costs and saving money.

____ 11. Preheat flames that are too hot can cause a bad cut with an irregular edges and excessive adhering slag.

Identify the parts of a combination cutting/welding torch by choosing the letter of the correct part name.



___ 12.
___ 13.
___ 14.
___ 15.
___ 16.
___ 17.
___ 18.
___ 19.
___ 20.

a. Acetylene fitting
b. Acetylene torch valve
c. Oxygen cutting lever
d. Oxygen fitting
e. Oxygen preheat valve
ab. Oxygen torch valve
ac. Slip-in tip
ad. Tip nut
ae. Torch body

ANSWERS TO ASSIGNMENT SHEET 1.1

1. T
2. T
3. F
4. T
5. T
6. T
7. F
8. T
9. T
10. T
11. T
12. d
13. a
14. ab
15. b
16. ae
17. c
18. e
19. ad
20. ac

MODULE: OXY-FUEL CUTTING/WELDING

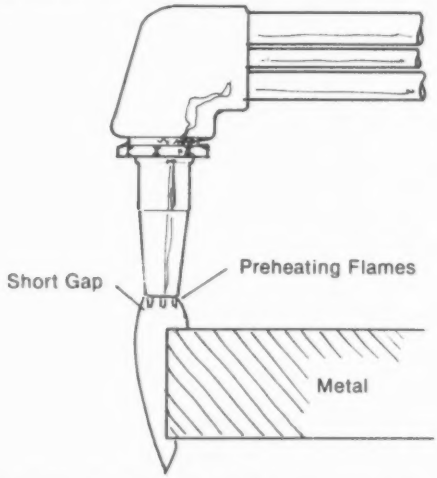
UNIT III: OXYACETYLENE CUTTING

LESSON 2: HAND CUTTING TECHNIQUE

I. Cutting straight lines

A. Steps for properly starting a cut

1. Place the cutting tip so that the preheat flames are half on the metal and half off the edge of the metal. Hold tip perpendicular to the metal surface.



2. The tips of the inner cones should be as close as possible to the metal without touching it.

3. Preheat starting point until metal is cherry red, then slowly depress the oxygen cutting lever.

4. When cutting starts, tilt the cutting tip slightly in the direction of the cut and move the tip at a constant speed along the cut line.

B. Techniques for restarting a cut

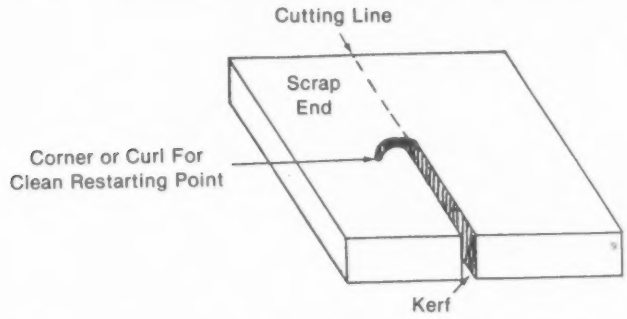
1. Anytime cutting stops, release the oxygen cutting lever immediately. Preheat the restarting point at the edge only, and start again as if beginning a cut.

2. Blowholes are the biggest problem with restarting a cut. Blowholes can be avoided.

a. Stop torch travel before releasing the oxygen cutting lever.

NOTE: This is especially effective on long cuts that will have one or more restarting points.

b. Move the torch into the scrap area beyond the cutting line to form a corner or a curl about 1/4" long so that the cut can be restarted in the scrap area and moved cleanly back to the original line.



NOTE: This technique allows torch repositioning at comfortable intervals on long cuts. When properly executed, the re-entry point can hardly be detected.

3. Avoid cutting across slag when restarting because the slag will fly in all directions and create a hazard.

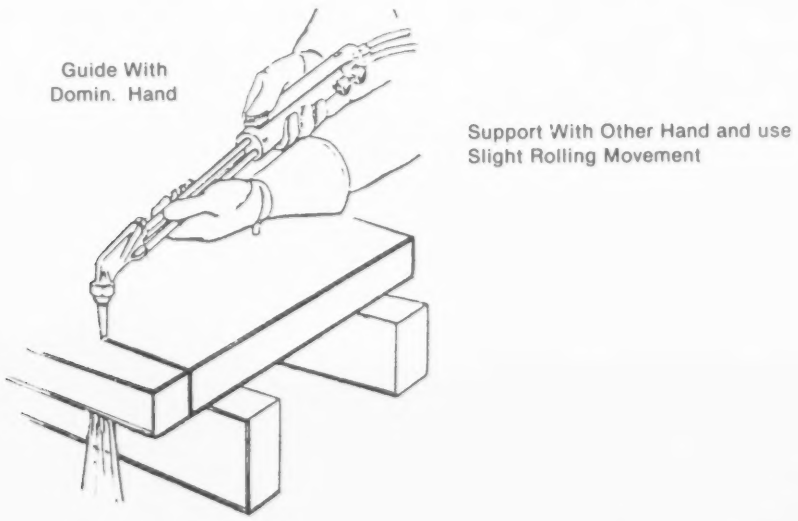
C. Technique for cutting straight lines

1. Hold the torch in your dominant hand with your thumb on the cutting lever and the torch centered in front of your body.

2. Support the torch in your other hand with a relaxed grip that will permit the torch to be turned.

3. As the torch moves along the cutting line, roll your other hand slightly outward from time to time to make the adjustment required to keep the cutting flame straight along the line.

NOTE: The slight rolling technique with the other hand is the secret to good, straight cuts.



START-UP, ADJUSTMENT AND SHUT-DOWN OF EQUIPMENT

Equipment:

Oxygen cylinder
Acetylene cylinder
Hoses
Oxygen and acetylene regulators
Torch body
Cutting attachment with slip-in tip
Cylinder holder and hose rack
Flint lighter
Wrench
Gloves
Welding goggles
Coveralls or protective clothing

Procedure:	Evaluation 3 2 1 N
1. Set up equipment safely as outlined in Unit I. Check all cylinders, regulators and torch valves to make sure they are off.	— — — —
2. Open acetylene cylinder valve 1/2 to 3/4 of a turn. Open acetylene valve on torch one turn.	— — — —
3. Turn adjusting screw on acetylene regulator clockwise until desired pressure is reached.	— — — —
NOTE: Oxygen and acetylene pressures and size of tip depend upon the thickness of the metal to be cut. Use pressures and tip size recommended by manufacturer.	
4. Close acetylene valve on torch. Open oxygen cylinder valve all the way.	— — — —
5. Open oxygen torch valve all the way. Open oxygen preheat valve on cutting attachment one turn.	— — — —
6. Turn adjusting screw on oxygen regulator clockwise until desired pressure is reached.	— — — —
7. Close oxygen preheat valve on cutting attachment.	— — — —
8. Open acetylene valve on torch 1/4 turn.	— — — —
9. Light torch with flint lighter and adjust until smoke on flame clears. Open oxygen preheat valve slowly and adjust to a neutral flame. Depress oxygen cutting lever and check that a neutral flame is present.	— — — —
NOTE: If necessary, adjust oxygen preheat valve with oxygen cutting lever depressed until a neutral flame is secured.	

10. On torch, close acetylene valve, oxygen preheat valve, acetylene cylinder valve, oxygen cylinder valve and acetylene valve. — — — —

NOTE: When gauges reach 0, close torch valve and release adjusting screw on acetylene regulator by turning counterclockwise.

11. Open oxygen preheat valve on torch. — — — —

NOTE: When gauges reach 0, close oxygen preheat valve and release adjusting screw on oxygen regulator by turning counterclockwise.

12. Close oxygen valve on torch. Place torch and hose on hanger or brackets provided. — — — —

13. Ask instructor to check your work. — — — —

14. Check in tools and equipment or prepare for next job sheet, as directed by instructor. — — — —

Average of above evaluations* — — — —

*This average is the student's final evaluation for competency C5: Light and adjust flame for welding and cutting.

MAKE 90-DEGREE CUTS ON MILD STEEL PLATE

Equipment:

Cutting outfit with tip
Mild steel plates
Soapstone with a sharp point or edge
Straightedge
Gloves
Welding goggles
Pliers
Protective clothing
Flint lighter
Welding or cutting table
Slag box
Can of water

Procedure:

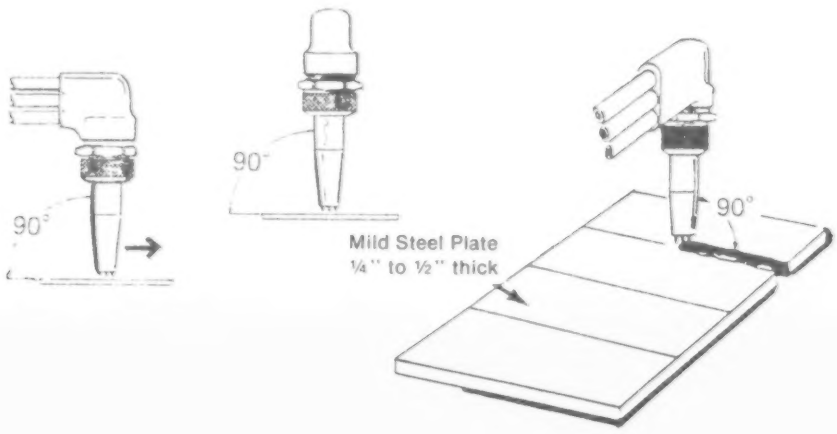
Evaluation 3 2 1 N

1. Adjust oxygen regulator. Adjust acetylene regulator. Place metal to be cut over slag box. — — — —

2. Light torch. Adjust to neutral flame. Assume comfortable position. — — — —

3. Place hoses behind operator. Maneuver torch with both hands. Hold preheat flame with tip of inner cone 1/16" to 1/8" above top of plate at right edge until red spot appears. — — — —

4. Depress oxygen cutting lever and move from right to left across the plate. (Left-handed operators move from left to right.) — — — —



5. Hold the tip at right angle to work, cutting with inner cone 1/16" to 1/8" above work. Make 90-degree cuts until you have developed the proper procedure. — — — —

6.	Cool metal by holding with pliers and placing in water. Show samples to instructor for approval and grading.	— — — —
7.	Release the oxygen cutting lever. Preheat only the edge where cutting action was stopped.	— — — —
8.	Slowly depress oxygen cutting lever and continue cut. Finish cut and shut down equipment.	— — — —
9.	Ask instructor to check your work.	— — — —
10.	Check in tools and equipment and clean area or proceed to next job sheet, as directed by instructor.	— — — —
	Average of above evaluations*	— — — —

*This average is the student's partial evaluation for competency C7: Make straight 90-degree and beveled cuts on mild steel plate and pipe.

MAKE BEVELED CUTS ON MILD STEEL PLATE

Equipment:

(see JS 2.2)
Sliding T bevel, protractor or combination square

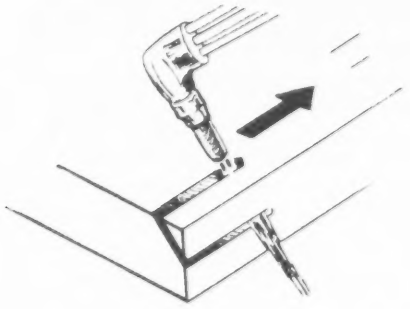
Procedure:

Evaluation
3 2 1 N

1. Adjust oxygen regulator. Adjust acetylene regulator. Place metal to be cut over slag box. — — — —

2. Light torch. Adjust to neutral flame. Assume comfortable position. — — — —

3. Place hoses behind operator. Hold torch with both hands at desired angle to metal, as shown. — — — —



4. Hold preheat flame with inner cone tip 1/16" to 1/8" above top of plate at right edge until red spot shows. — — — —

5. Depress oxygen cutting lever and proceed across plate with very consistent movement, being careful to maintain constant travel speed, torch angle and flame-to-work distance. — — — —

6. Hold tip at right angles to work, cutting with inner cone 1/16" to 1/8" above work. Practice until you develop the proper procedure. — — — —

7. Ask instructor to check your work. — — — —

8. Check in tools and equipment and clean area or prepare for the next job sheet, as directed by instructor. — — — —

Average of above evaluations* — — — —

*This average is the student's partial evaluation for competency C7.

CUT HOLE IN MILD STEEL

Equipment:

(see JS 2.2)
Circle-drawing equipment (center punch and compass, washer or small pipe)

Procedure:

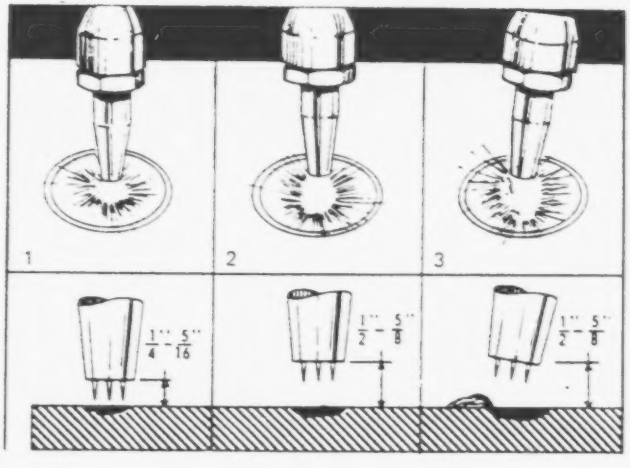
Evaluation
3 2 1 N

1. Draw two circles on metal: 1" in diameter, 1" from edge; and 1/2" in diameter, 1" from edge. — — — —

2. Adjust oxygen and acetylene regulators. Place metal to be cut over slag box. — — — —

3. Light torch. Adjust to neutral flame. Assume comfortable position. — — — —

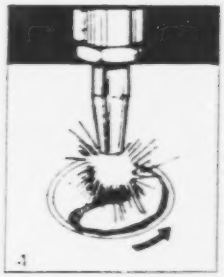
4. Place hoses behind operator. Maneuver torch with both hands. Hold tips of inner cones 1/16" to 1/8" above point to be cut until metal turns bright red. — — — —

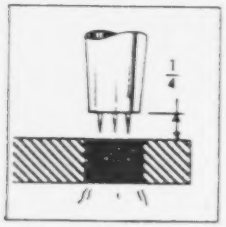


5. Slowly depress cutting oxygen lever; at the same time, tilt the torch 15 degrees from vertical and raise tip approximately 1/2" to 5/8" above the metal's surface. — — — —

NOTE: Tilting the torch allows the molten metal to be blown away from the operator, while raising the tip helps prevent slag from blowing back into the tip orifices.

6. Return cutting torch to vertical position when oxygen jet and slag stream exit the bottom side of metal being cut. Lower cutting tip until tip of inner cones are from 1/16" to 1/8" above plate. Make cut. — — — —





7. Cut just inside soapstone mark until circular cut is completed. — — — —

8. Repeat 4-7 until all holes are cut. — — — —

9. Cool metal by holding with pliers and placing in water. — — — —

10. Ask instructor to check your work. — — — —

11. Check in tools and equipment and clean area or prepare for next job sheet, as directed by instructor. — — — —

Average of above evaluations* — — — —

*This average is the student's final evaluation for competencies C6, C8 and A13.

LAY OUT AND CUT PATTERN TO SPECIFICATIONS

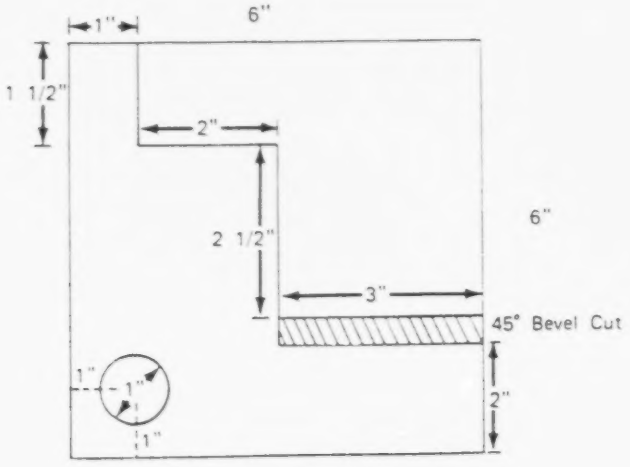
Equipment: (see JS 2.2)
Protractor, compass or sliding T bevel

Procedure:

Evaluation
3 2 1 N

1. Select starting point. Measure distances and mark. — — — —

2. Ask instructor to check your drawing.



3. Place plate on cutting table. Set up cutting equipment and select appropriate tip for metal thickness. — — — —

4. Light and adjust cutting torch flame. Make straight or bevel cuts as required for pattern specifications. — — — —

5. Turn off torch. Secure hot workpiece with pliers. — — — —

6. Chip slag from all cuts as required. Inspect for proper torch angles, draglines and straightness. — — — —

7. Ask instructor to check your work. — — — —

8. Shut down cutting equipment. — — — —

9. Check in tools and materials and clean area or prepare for next job sheet, as directed by instructor. — — — —

Average of above evaluations* — — — —

*This average is the student's partial evaluation for competency C9.

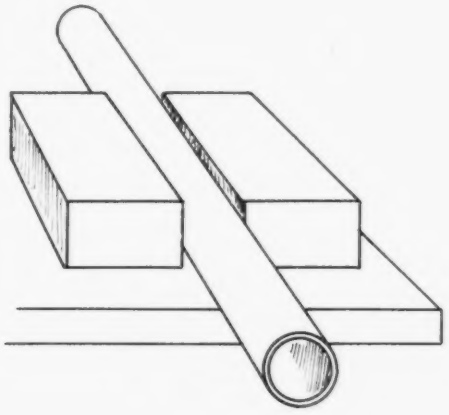
SET UP AND CUT PIPE BEVEL

Equipment:

Oxyacetylene cutting unit with tip
Welding goggles
Welding gloves
Sparklighter
Pliers
Wraparound
Soapstone marker
Center punch (optional)
Pipe with at least 3/16" wall thickness
Tip wrench, if required
File
Wire brush

Procedure:

		Evaluation 3 2 1 N
1.	Inspect area to make sure it is free of flammable materials and is well ventilated. Note location of nearest fire extinguisher.	— — — —
2.	Select tip according to wall thickness of pipe. Place on torch and tighten according to manufacturer's recommendations.	— — — —
3.	Place pipe on a suitable work surface and brace with pieces of fire brick so pipe can be rotated.	— — — —



4. Place wraparound over pipe. Make sure it overlaps to give a straight line, then mark the cutting line with soapstone. — — — —

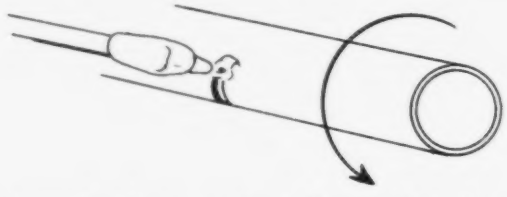
   NOTE: When preheating the cutting line, soapstone may burn off. You may want to mark the cutting line with a center punch at a few points.

5. Put on welding gloves and goggles. Light and adjust torch to neutral flame. — — — —

6. Start preheating on the sidewall of the pipe at a point slightly down from the top (at about the 10:00 or 11:00 position). Angle the torch tip at the starting point so that it will make a cut of 35 degrees through the pipe wall. — — — —

7. Move the torch down until the inner flame is about 1/16" to 1/8" from the pipe surface and heat a spot about the size of a dime until it turns a bright, cherry red. — — — —

8. Turn on oxygen cutting valve slowly. Cut for a few inches to the left (if you're right-handed), then stop and rotate the pipe to the left. — — — —



9. Restart cut by preheating as required. Keep making short cuts to the left while rotating the pipe until the cut is complete. — — — —

10. Close oxygen cutting valve. Turn torch off. — — — —

11. Use file to clean slag from inside the pipe and rough edges from the bevel, then clean with a wire brush. — — — —

12. Ask instructor to check your work. — — — —

13. Continue cutting bevels as directed by instructor. — — — —

14. Shut down equipment. Check in tools and materials. — — — —

Average of above evaluations* — — — —

*This average completes the student's evaluation for competency C9: Layout, cut and fit pipe, plate and structural shapes.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT III: OXYACETYLENE CUTTING

LESSON 3: MOTORIZED CUTTING TECHNIQUES

I. Characteristics of cutting machines

A. Tractor-type

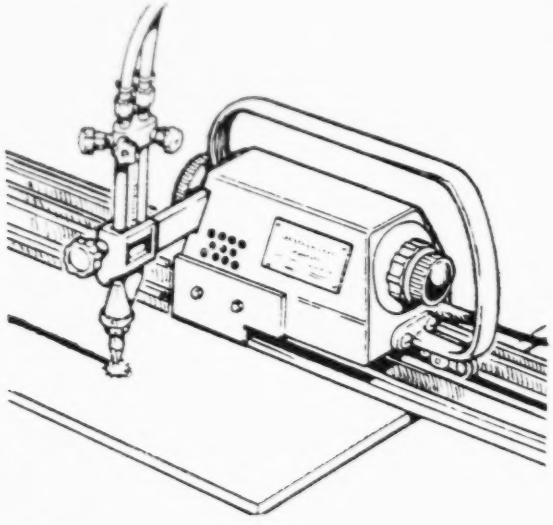
1. Tractor-type cutting machines almost always require set-up, alignment and adjustment by an operator.

2. Operating on tracks is mostly confined to horizontal cutting, although some models have magnetic tracks that permit them to cut in vertical or overhead positions.

3. Tractor machines are powered by a motor-driven carriage with governor-controlled speed.

4. Many models have provisions for mounting two torches.

5. Tractor machines are used mostly for making square or beveled cuts but can be modified with a radius rod to cut circles.

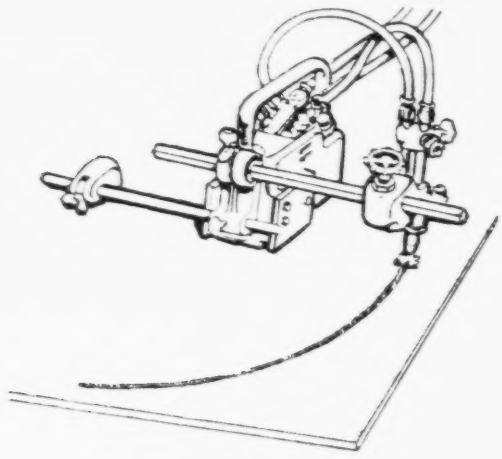


B. Hand-guided cutting machines

1. Vary in design with 1-3 wheels and attachments for cutting straight lines, bevels, circles and irregular shapes

2. Can be used to cut horizontally or vertically; adjustable to many steel forms including rod and pipe

3. Controlled by operators who oversee speed and direction of cutting torch, which is centered in front of or beside a drive wheel



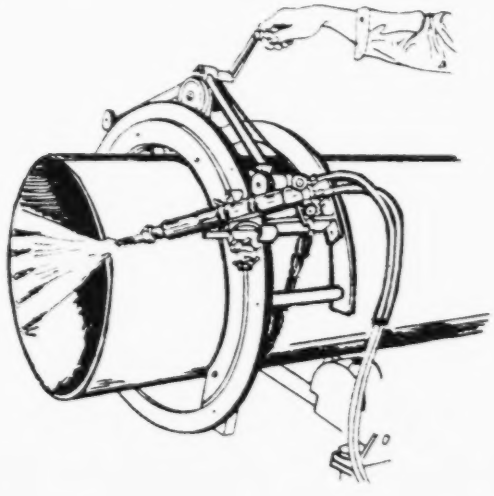
C. Pipe beveling machines

1. Specially designed for cutting beveled angles, Ts, Ys and other connecting shapes for pipe

2. May be motorized or manually operated

3. Split horseshoe design that fits the inside or outside contour of the pipe and is then clamped into position for cutting

4. Torch holders have easy-to-read protractors for precise control of cutting angle.



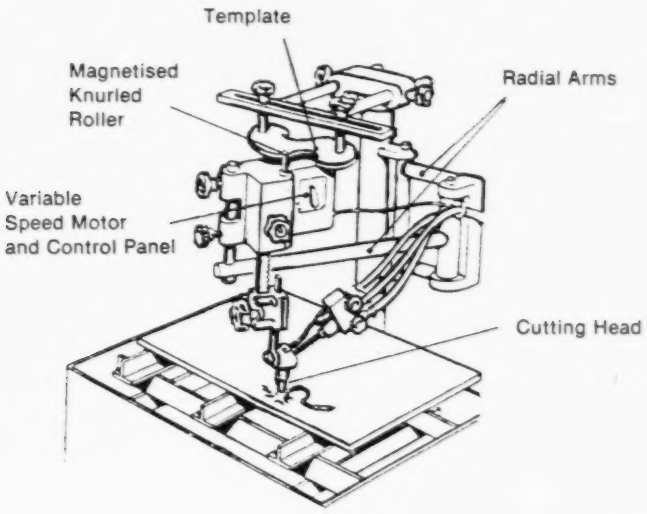
D. Shape-cutting machines

1. These machines are usually designed for specific job requirements where the cutting of multiple identical shapes contributes to high productivity.

2. They function as (1) tracing machines that use a photocell or electric eye to trace a pattern or (2) magnetic devices to follow a metal template.

3. Gas torch control functions are operated from a terminal or panel to provide precise operator control.

4. Machines may be numerically programmed with a punched tape fed into a master control unit or digitally controlled with solid-state devices on a push-button control panel.



MOTORIZED CUTTING TECHNIQUE

Mark a T before true statements and an F before false ones.

___ 1. Hand-guided cutting machines vary in design with 1-3 wheels and attachments for cutting straight lines, bevels, circles and irregular shapes.

___ 2. Hand-guided cutting machines are adjustable to many steel forms but can only be used to cut horizontally.

___ 3. Hand-guided cutting machines are controlled by operators who monitor speed and direction of the cutting torch, which is centered in front of or beside a drive wheel.

___ 4. Shape-cutting machines are usually designed for specific job requirements where the cutting of multiple identical shapes contributes to high productivity.

___ 5. Shape-cutting machines function as tracing machines that use either a photocell or electric eye to trace a pattern or magnetic devices to follow a metal template.

___ 6. Gas torch control functions are operated from a terminal or panel to provide precise operator control.

___ 7. Shape-cutting machines can be numerically programmed with a punched tape fed into a master control unit or controlled digitally with solid-state devices on a push-button control panel.

Choose the letter which corresponds to the best answer.

___ 8. Pipe-beveling machines are designed specifically for cutting _____.

a. Beveled angles, Ts, Ys and other connecting shapes for pipe
b. 90-degree angles, Ts, Ys and other connecting shapes for pipe
c. Only Ts, Ys and other connecting shapes for pipe
d. Only Ts and Ys

___ 9. The basic design of a pipe-beveling machine is a _____ that fits the _____ contour of the pipe and is then clamped into position for cutting.

a. Split horseshoe, inside or outside
b. Split horseshoe, outside
c. Split horseshoe, inside
d. Fixed horseshoe, inside

___ 10. Torch holders are designed with easy-to-read _____ for precise control of cutting angle.

a. Meters
b. Digital controls
c. Gauges
d. Protractors

___ 11. These machines operate on tracks mostly confined to _____ cutting, but some models have _____ tracks that permit them to cut in _____ positions.

a. Horizontal, magnetic, horizontal
b. Horizontal, magnetic, vertical or overhead
c. Vertical, magnetic, horizontal
d. Vertical, non-magnetic, horizontal

ANSWERS TO ASSIGNMENT SHEET 3.1

1. T
2. F
3. T
4. T
5. T
6. T
7. T
8. a
9. a
10. d
11. b

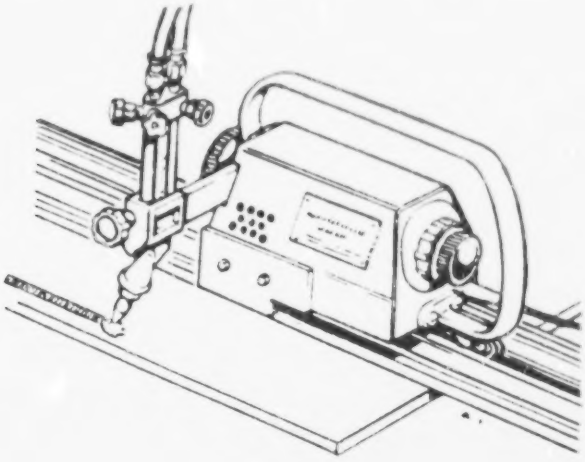
SET UP AND CUT 30-DEGREE BEVEL WITH TRACTOR-TYPE TORCH

Equipment:

Oxyacetylene cutting unit with tractor-type torch
Welding goggles
Welding gloves
Sparklighter
Pliers
Straightedge
Soapstone
Metal as selected by instructor
Tip wrench, if required

Procedure:	Evaluation 3 2 1 N
1. Inspect area to make sure it is free and clear of flammable materials and well ventilated. Note the location of the nearest fire extinguisher. Select tip according to thickness of metal. Place tip on torch and tighten according to manufacturer's recommendations.	— — — —
2. Place material on work area and set up tractor and torch. Adjust protractor on torch unit to a 30-degree angle.	— — — —
3. Determine direction of travel. Determine travel speed according to size and thickness of metal as recommended by the manufacturer.	— — — —
4. Put on cutting gloves and goggles. Light and adjust torch to neutral flame.	— — — —
NOTE: Lighting and adjusting a tractor-type torch uses the same procedure as that for a hand-held torch. The same safety rules should be observed, also.	
5. Make preliminary run with torch at 5-10 degree angle.	— — — —

6. Roll the tractor to a point where the flame is at the edge of the metal. Adjust the flame so that the inner cone is 1/16" to 1/8" off the metal. Hold the flame at the edge of the metal until the plate turns a bright, cherry red. — — — —



7. Open oxygen cutting valve and immediately activate the tractor drive motor. Permit tractor and torch to run the length of the cut to complete the bevel. — — — —

CAUTION: NEVER leave an activated tractor-type machine unattended for any length of time.

8. Close oxygen cutting valve. Disengage tractor drive motor, and turn motor off. Turn torch off. — — — —

9. Inspect bevel for correctness of angle dragline and slag accumulation. — — — —

CAUTION: When you remove the workpiece for inspection, use pliers.

10. Ask instructor to check your work. Continue practice with cutting bevels as directed. — — — —

11. Clean work area and check in tools and materials or prepare for next job sheet, as directed by your instructor. — — — —

Average of above evaluations* — — — —

*This average completes the student's evaluation for competency C7: Make straight 90-degree and beveled cuts on mild steel plate and pipe.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT III: OXYACETYLENE CUTTING

UNIT TEST

Choose the option which best answers the question or completes the statement.

___ 1. Cutting tips can be quickly changed so cutting can be rapidly adapted to different _____ .

a. Joint designs
b. Welding positions
c. Altitudes
d. Metal thickness

___ 2. What types and quantity of orifices are found on cutting tips?

a. One preheat and one oxygen
b. One preheat and two oxygen
c. Two or more preheat and one oxygen
d. Two preheat and two oxygen

___ 3. What type of orifice provides a mixture of oxygen and acetylene for preheating metal?

a. Oxygen
b. Preheat
c. General purpose
d. Propane

___ 4. Which type of orifice directs a pressurized stream of pure oxygen onto the heated metal to accelerate the oxidation process that burns away metal?

a. Single oxygen
b. Double oxygen
c. Preheat
d. General purpose

___ 5. How are oxyacetylene welding tips tightened?

a. Only finger-tight
b. Finger-tight; some are then wrench tightened
c. Only with a special-purpose wrench
d. Only with an adjustable wrench

___ 6. When choosing a cutting tip, _____ .

a. Determine thickness of material to be cut and use the size tip recommended by the manufacturer
b. Measure the material length to be cut and use the size tip recommended by the manufacturer
c. Determine thickness of material to be cut and choose the size tip which looks most appropriate
d. Determine thickness of material to be welded and choose the size tip recommended by a co-worker

___ 7. Tip size has a direct relation to _____ pressures.

a. Oxygen
b. Acetylene
c. Cutting lever
d. Gas regulator

___ 8. Tip size affects _____ and should be based on the needs of the cutting application.

a. Cut depth
b. Torch handling
c. Rate of cutting speed
d. Only the metal's finish

___ 9. Because cutting tips inevitably pick up slag, they need to be cleaned _____.

a. With strong solvent
b. Once in a while
c. Often
d. Every hour

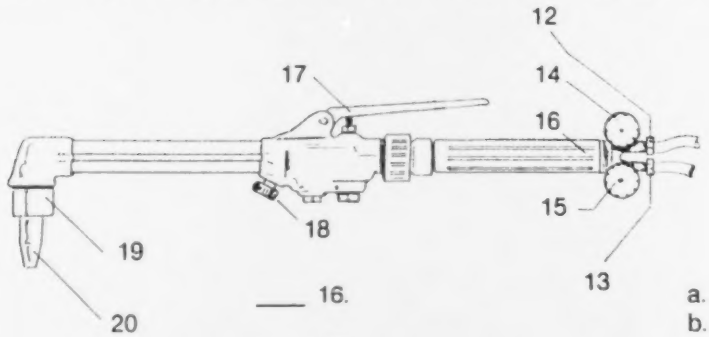
___ 10. What should always be smaller in diameter than the orifice being cleaned?

a. Tip nut
b. Cleaning probe
c. Cleaning brush bristles
d. Tip nip

___ 11. Which is true of cutting tips?

a. They are nearly immune to damage.
b. They provide a mixture of acetylene and nitrogen.
c. Cutting tips are not easily changed.
d. Seating edges of some cutting tips can be easily damaged.

Match combination cutting/welding torch parts and other terms to the appropriate descriptors.



___ 12.
___ 13.
___ 14.
___ 15.
___ 16.
___ 17.
___ 18.
___ 19.
___ 20.

a. Acetylene fitting
b. Acetylene torch valve
c. Drag line
d. Kerf
e. Oxygen cutting lever
ab. Oxygen fitting
ac. Oxygen preheat valve
ad. Oxygen torch valve
ae. Slag
bc. Slip-in tip
bd. Tip cleaner
be. Tip drill
cd. Tip nip
ce. Tip nut
de. Torch body

___ 21. Used for cleaning and reconditioning orifices

___ 22. A device with a series of small file-like probes that are gauged to match specific orifice openings and remove carbon build-up inside the tip

___ 23. A circular-shaped device with small steel cutting blades inset so it can be placed over the entire end of the tip to both clean and restore the face of the tip

___ 24. A condition where the most distant portion of the cutting stream lags behind the stream nearest the cutting

___ 25. Cut made by a cutting torch

___ 26. Porous oxidized residue left after oxyacetylene cutting

Choose the option which best answers the question or completes the statement.

____ 27. Which is not a true statement about proper tip use?

a. A tip should never be used as a hammer to chip slag off a cut.
b. A tip should never be cleaned by rubbing it on fire brick or against anything not designed for tip cleaning.
c. An oily or greasy wrench should not be used to tighten a cutting tip.
d. An oil rag is a good tip cleaning tool because it keeps the tip lubricated.

____ 28. For all critical cutting that requires following layout lines, metal should be ____ .

a. Cleaned with a mild solvent
b. Burnt free of oil and grease
c. Scraped free of scale
d. Smoothed with a grinder

____ 29. Good oxyacetylene cutting should produce a clean kerf with minimum drag. This requires _____ .

a. A steady hand while welding
b. Proper tip selection, travel speed and fuel gas pressures
c. Proper tip selection and air pressure
d. Proper travel speed and a sharp tip

____ 30. For plate thickness of 1/4" to 1/2", the torch should be angled about _____ degrees from the base metal surface, while plate thicker than 1/2" requires a _____ angle.

a. 60-70, 90
b. 50-60, 90
c. 40, 90
d. 45, 90

____ 31. High oxygen pressure used in oxyacetylene cutting creates _____ that demand _____ .

a. Drafts, heavier clothing
b. Dangerous conditions, evacuation by all but the welder
c. Showering sparks, a 50' safety area
d. Showering sparks, shielding screens

____ 32. Which is not true of oxyacetylene cutting?

a. Units are readily portable and can be taken to the work site.
b. Equipment is relatively inexpensive when compared to other cutting procedures.
c. Cutting can usually be accomplished quickly but is probably the slowest method of cutting thicker metals or odd shapes.
d. Cutting can be adapted to automatic processes.

___ 33. Which is not true about manifold systems and O-A cutting/welding?

a. These systems pipe fuel gas supplies from two or more tanks where only one cylinder would be inadequate.
b. An acetylene manifold doesn't need a water seal flash arrester.
c. A manifold system should be large enough to supply volume for the average size tip used.
d. They save space when a number of work stations are required.

___ 34. Which is an improper working surface for oxyacetylene cutting operations?

a. Sturdy saw-horse wooden table
b. Fire-brick work table
c. Cutting table
d. Sanded masonry floor

___ 35. When cutting a straight line, right-handed operators hold the torch in the right hand with the thumb on the cutting lever and the torch _____ the operator's body.

a. Centered in front of
b. Just to the left of
c. Just to the right of
d. In a comfortable position near

___ 36. In the above situation, the torch is supported by the left hand with a _____ grip that will permit the torch _____ .

a. Firm, not to turn
b. Relaxed, to be turned
c. Relaxed, not to turn
d. Firm, not to turn

___ 37. As the torch moves along the above cutting line, the left hand _____ occasionally to make the adjustment required to keep the cutting flame straight along the line.

a. Rolls slightly to the right
b. Taps the torch
c. Rolls slightly to the left
d. None of the above

___ 38. Which type of machine is usually designed for specific job requirements where the cutting of multiple identical shapes contributes to high productivity?

a. Tractor-type cutting machine
b. Pipe-beveling machine
c. Shape-cutting machine
d. None of the above

39. List five reasons for poor cuts.

a.

b.

c.

d.

e.

ANSWERS TO UNIT TEST (C7)

1. d
2. c
3. b
4. a
5. a
6. a
7. d
8. c
9. c
10. b
11. d
12. ab
13. a
14. ad
15. b
16. de
17. e
18. ac
19. ce
20. bc
21. be
22. bd
23. cd
24. c
25. d
26. ae
27. d
28. b
29. b
30. a
31. d
32. c
33. b
34. a
35. a
36. b
37. c
38. c

39. Any five of the following:
    a. Preheat flames are not hot enough so the cutting speed is too slow, causing bad gouging at the bottom.
    b. Preheat flames are too hot so the top surface melts over. The cut edge is irregular with an excessive amount of adhering slag.
    c. Oxygen pressure is too low, and the top edge melts over because of the slow cutting speed.
    d. Oxygen pressure is too high, and the nozzle size too small. Control of the cut is lost.
    e. Cutting speed is too slow so irregularities of draglines are emphasized.
    f. Cutting speed is too high so there is a pronounced break to the dragline, and the cut edge is irregular.
    g. Torch travel is unsteady so the cut edge is wavy and irregular.
    h. Cut is lost and not carefully restarted so that bad gouges are caused at the restarting point.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT IV: ADDITIONAL PROCESSES

UNIT OBJECTIVES

Upon completion of this unit, the student should be able to identify principles of braze welding, bronze surfacing, hard surfacing and the use of alternate fuel gases in oxy-fuel welding and cutting. This knowledge will be evidenced by achieving the specified score on the unit test and job sheets.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms related to oxyacetylene braze welding and hard surfacing with definitions.

1.2 Differentiate between characteristics of braze welding and other processes.

1.3 Select true statements concerning the characteristics of filler rods for braze welding.

1.4 Complete statements concerning three important factors in successful braze welding.

1.5 Select true statements concerning techniques for braze welding steel and cast iron.

1.6 Complete statements concerning advantages and limitations of various rebuilding and resurfacing processes.

1.7 Demonstrate the ability to:

a. Weld a stringer bead on steel plate with a bronze rod.*

b. Braze weld carbon steel and cast iron.*

c. Braze weld a lap joint in the horizontal position.*

2.1 Complete statements concerning hard surfacing uses.

2.2 Match hard-surfacing alloys with characteristics.

2.3 Select true statements concerning hard-surfacing powders.

2.4 Select true statements concerning advantages of hard surfacing with an oxyacetylene torch.

2.5 Select true statements concerning preparation for hard surfacing.

2.6 Complete statements concerning preheating and cooling requirements for hard surfacing.

2.7 Select true statements concerning techniques for oxyacetylene hard surfacing.

2.8 Complete statements concerning safety precautions for hard surfacing.

2.9 Demonstrate the ability to repair a worn tool with hard surfacing.

3.1 Identify the characteristics of oxy-fuel gases: acetylene, propane, mapp and natural gas.

*Addresses competency on profile

MODULE: OXY-FUEL CUTTING/WELDING

UNIT IV: ADDITIONAL PROCESSES

CONTENTS OF THIS UNIT

A. Objective pages

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: BRAZE WELDING

   a. Information outline

   b. Assignment sheet

      AS 1.1: Braze welding

   c. Answers to assignment sheet

   d. Job sheets

      JS 1.1: Weld stringer bead on steel plate with bronze rod
      JS 1.2: Braze weld carbon steel
      JS 1.3: Braze weld lap joint in horizontal position
      JS 1.4: Braze weld cast iron

2. Lesson 2: HARD SURFACING

   a. Information outline

   b. Handout

      HO 2.1: Metals preheating chart

   c. Assignment sheet

      AS 2.1: Hard surfacing

   d. Answers to assignment sheet

   e. Job sheet

      JS 2.1: Repair a worn tool with hard surfacing

3. Lesson 3: ALTERNATE FUEL GASES

   a. Information outline

E. Unit test

F. Answers to the unit test

REFERENCES

A. Books

1. Operator's Manual for Oxy-Fuel Gas Cutting. Miami: American Welding Society, 1978.

2. Instruction Manual, Welding and Cutting, and Lead-Burning. St. Louis: Modern Engineering Company, Inc., 1970.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Oxy-acetylene Welding and Cutting. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. JS 2.1 and corresponding information has been provided for instruction on hard surfacing. Obtain used plow shares or comparable worn equipment for students to use in completing the hard-surfacing procedure, if desired.

2. Demonstrate the proper use of flux and discuss the importance of flux in certain brazing and hard surfacing applications.

3. Demonstrate proper procedure for preheating and tinning.

4. Give a demonstration of how to use a gouging tip properly for grooving metal and removing improper welds.

B. Suggested student activities

1. Visit a local or area welding shop that specializes in hard surfacing. Have students report on the types of parts being rebuilt and the techniques observed.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT IV: ADDITIONAL PROCESSES

LESSON 1: BRAZE WELDING

I. Terms and definitions

A. Tinning--the process of placing a thin film of filler metal along the joint of a pre-heated base metal

B. Flux--a chemical in paste or powder form used to clean metal, protect it from oxidation and promote fusion in a welding process

C. Oxidation--the chemical reaction of a metal to the oxygen in the air; a process that promotes contamination of metal surfaces and eventually leads to rust

D. Scale--contaminants that form in flaky configurations on the surface of a metal which are usually the result of oxidation

E. Machining--a process of mechanically grinding or milling surfaces, edges and corners to precise dimensions on a workpiece to be welded; also used to finish the workpiece after welding

F. Oxidizing flame--a flame with more oxygen than a neutral flame

G. Carburizing flame--a flame with more acetylene than a neutral flame

H. Gouging--the process of making a groove or bevel in a base metal without cutting completely through it. With oxyacetylene equipment, the process requires a bent nozzle that supplies a relatively low-velocity oxygen cutting stream.

II. Braze welding characteristics

A. Difference between fusion and braze welding

1. In fusion welding, the filler rod's and the base metal's melting point are approximately the same. Both the filler metal and the base metal are melted and fused together.

2. In braze welding, the filler rod has a melting point <u>below</u> that of the base metal. The base metal is never melted; the weld is formed as a result of capillary attraction or by gravity pull resulting from weld design.

B. Difference between brazing and braze welding

1. In brazing, filler metal must have a melting point above 800F but lower than the base metal's melting point. Filler metal is drawn into a tightly fitting joint by capillary attraction.

2. In braze welding, the filler metal must have a melting point above 800F but lower than the base metal's melting point. Filler metal is deposited into the joint by gravity pull in the joint design, not by capillary attraction.

C. Advantages of braze welding

1. Faster than fusion welding because heat input required is less
2. Saves time and reduces fuel gas consumption
3. Minimizes preheating requirements
4. With cast iron, the reduction of heat input contributes to the flexible filler metal's absorption of stress as it cools.
5. Reduces distortion of the base metal
6. Can be used to join dissimilar metals that cannot be fusion welded, such as copper to brass
7. Braze welded steel or cast iron can produce a weld equal or greater in strength than the original base metal.

D. Limitations of braze welding

1. Cannot match weld color to the color of the base metal
2. Cannot be used on metals and joints where stress is a factor
3. Will lose its strength at temperatures above 500F
4. May have corrosion-resistant properties different from those of the base metal

E. Purposes of flux

1. Chemically cleans the base metal
2. Prevents oxidation of the filler metal
3. Floats and removes oxides already present
4. Increases the flow of the filler metal
5. Increases the ability of filler metal to adhere to base metal
6. Brings filler metal into immediate contact with base metals being joined
7. Permits the filler metal to penetrate base metal pores

III. Characteristics of filler rods for braze welding

A. Consist of copper alloys containing about 60-40 copper and zinc

1. Produce a high-tensile strength

2. Increase flexibility

B. Contain small quantities of tin, iron, manganese and silicon

1. Deoxidize the weld metal

2. Decrease fuming tendency

3. Increase the free-flowing action of the molten metal

4. Increase deposited metal hardness for greater wear resistance

C. Should be cleaned with emery cloth before use

IV. Three important factors in successful braze welding

A. Cleaning and preparation of the joint

1. Generally, joints for braze welding are prepared in the same way as for base metals of like thickness in fusion welding

2. For base metal no thicker than 1/8" to 3/16", use square edges; for metals thicker than 3/16", use beveled edges.

3. In all cases, every part of the base metal to be tinned must be cleaned thoroughly until it is completely free of rust, scale, oil and grease.

4. Base metal should be cleaned at least 1/2" back from the edge of the joint whenever possible.

5. Removing oxides in joint preparation for braze welding

a. Oxides can be removed mechanically (with a wire brush or a portable grinder) or chemically with a suitable flux.

b. Sometimes cleaning requires both methods.

B. Proper tinning of entire joint achieved through cleaning action of the flux and proper metal temperature

1. The basic element of braze welding is based on the principle that brass and bronze, when raised to the proper temperature, will melt and form a smooth film (tinning) on the surface of a properly prepared and heated joint.

2. Tinning cannot be properly accomplished unless the joint has been thoroughly cleaned and properly prepared.

3. Good tinning usually requires a neutral to slightly oxidizing flame and a good brazing flux.

4. Improper tinning action is almost always caused by overheating the base metal.

C. Complete fusion between layers of filler metal when the weld is made in two or more passes

V. Techniques for braze welding steel and cast iron

A. Select a welding tip at least one size smaller than one selected for fusion welding.

B. Adjust torch to a slightly oxidizing flame.

C. Move the flame back and forth over a generous area of the base metal until it begins to glow dull red.

D. As the base metal starts to glow, heat the end of the filler rod and dip it in flux until it is well coated.

NOTE: To flux longer rods, spread the flux out along the inside corner of a piece of angle iron so the entire length of the rod can be dipped in the flux at one time.

E. Move the rod into the flame until it comes in contact with and melts off onto the base metal.

F. The temperature is just right when the melted bronze flows smoothly onto the base metal's surface and flows evenly over a large area.

G. Braze welding problems and causes

1. If the molten bronze forms into drops, the base metal is not hot enough.

2. If the molten bronze tends to bubble and boil, the base metal is too hot.

VI. Rebuilding and resurfacing processes and procedures

A. Bronze surfacing: the use of braze welding techniques and materials to rebuild or resurface worn parts

B. Hard surfacing: a welding process designed to deposit specialized alloys onto parts subject to extensive wear so the parts will become more resistant to abrasion, corrosion, impact or high temperature

C. Advantages of bronze surfacing

1. When bronze is applied to steel or cast iron parts subject to sliding friction, the reconditioned parts sometimes give longer service than new parts (examples: pistons, rotary valves and large gears).

2. When large pistons have to be replaced, the cost of bronze surfacing is much less than the cost of a new piston. Pistons rebuilt in this way will sometimes outlast new pistons.

3. Cast iron gears can be rebuilt faster at less cost with bronze welding.

D. Limitations of bronze welding

1. Bronze surfacing should not be used on parts that will be subjected to temperatures above 500F (example: superheated steam engine pistons).

2. Bronze surfacing should not be used on parts that will be subjected to alternating tensile and compressive stresses (example: piston rods).

E. Preparation for bronze surfacing

1. New or almost new surfaces should be machined or ground--or in some cases just thoroughly cleaned--before bronze is applied.

2. On cast iron surfaces, remove excess metal by grinding or sand-blasting since machining could leave graphite smears that make proper tinning difficult.

F. Techniques for bronze surfacing

1. Remember that bronze surfacing is essentially a braze welding process.

2. When preheating a cast iron part, don't isolate the flame in one spot too long. Move the flame around to distribute heat evenly and avoid cast iron cracking.

3. When preheating steel, avoid excessive heat build-up in one area, which could cause permanent distortion of the steel part.

4. Use a slightly oxidizing flame and a good brazing flux.

5. Plan the application so that the job can be completed without interruption to avoid variances in quality.

6. Keep the layer of bronze just thick enough so that the lowest spots will still require some machine finishing.

7. Always allow the part to cool slowly to room temperature before machine finishing.

OXYACETYLENE BRAZE WELDING

Differentiate between fusion welding and braze welding by placing a "b" beside braze welding statements and an "f" for fusion welding.

____ 1. The filler rod has a melting point approximately the same as the base metal's melting point. Both the filler metal and the base metal are melted and fused together.

____ 2. The filler rod has a melting point below that of the base metal. The base metal is never melted, and the weld is formed as a result of capillary attraction or by gravity pull resulting from weld design.

____ 3. In this procedure, the filler metal must have a melting point above 800F but lower than the melting point of the base metal. The filler metal is drawn into a tightly fitting joint by capillary attraction.

Place a T before true statements and an F before false ones.

____ 4. Braze welding is faster than fusion welding because the heat input required is less.

____ 5. Braze welding saves time and reduces fuel gas consumption.

____ 6. Braze welding minimizes preheating requirements.

____ 7. The reduction of heat input has special advantages for welding cast iron because the extremely flexible filler metal can absorb stresses as it cools.

____ 8. Because of a reduction in contraction and expansion, braze welding on steel reduces base metal distortion.

____ 9. Braze welding can be used to join dissimilar metals, such as copper to brass, that cannot be fusion welded.

____ 10. Even when properly executed, braze welding steel or cast iron can never produce a weld equal or greater in strength than the original base metal.

____ 11. Braze welding cannot match the weld color to the color of the base metal.

____ 12. Braze welding cannot be used on metals and joints where stress is a factor.

____ 13. Braze welding loses its strength at temperatures above 200F.

____ 14. The corrosion-resistant properties of braze welding may be different from those of the base metal.

____ 15. The purpose of flux is to chemically clean base metal.

____ 16. Flux prevents oxidation of the filler metal.

____ 17. Flux floats and removes the oxides already present.

____ 18. The flow of the filler metal is decreased when flux is used.

____ 19. Flux decreases the ability of filler metal to adhere to base metal.

____ 20. The filler metal is brought into immediate contact with the base metals being joined when flux is used.

____ 21. Flux permits filler metal to penetrate the pores of the base metal.

____ 22. A filler rod for braze welding consists of copper alloys containing about 60 percent copper and 40 percent zinc.

____ 23. Braze welding filler rods contain small quantities of tin, iron, nickel and silicon.

____ 24. Filler rods for braze welding do not require cleaning before use.

____ 25. Generally, joints for braze welding are prepared the same as for fusion welding for base metals of like thickness.

____ 26. When the base metal is no thicker than 1/8" to 3/16", square edges may be used.

____ 27. In all cases, every part of the base metal to be tinned must be cleaned thoroughly until it is completely free of rust, scale, oil and grease.

____ 28. When braze welding steel and cast iron, select a welding tip at least one size larger than would be selected for fusion welding a metal of equal thickness.

____ 29. When braze welding steel and cast iron, adjust torch to a slightly carburizing flame.

____ 30. As the base metal starts to glow bright red, heat the end of the filler rod and dip it in flux until it is well coated (braze welding).

____ 31. When the melted bronze flows smoothly onto the surface of the base metal and flows evenly over a large area, the temperature is just right for braze welding.

____ 32. When preheating steel for bronze surfacing, avoid excessive heat build-up in one area or it could cause permanent distortion of the steel part.

____ 33. Use a slightly carburizing flame and a good brazing flux for bronze surfacing.

____ 34. When bronze surfacing, keep the layer of bronze just thick enough so that the highest spots will still require some finishing machining.

____ 35. Always allow the part to cool quickly to room temperature before machine finishing.

ANSWERS TO ASSIGNMENT SHEET 1.1

1. f
2. b
3. b
4. T
5. T
6. T
7. T
8. T
9. T
10. F
11. T
12. T
13. F
14. T
15. T
16. T
17. T
18. F
19. F
20. T
21. T
22. T
23. F
24. F
25. T
26. T
27. T
28. F
29. F
30. F
31. T
32. T
33. F
34. F
35. F

WELD STRINGER BEAD ON STEEL PLATE WITH BRONZE ROD

Equipment:

Oxyacetylene welding unit with brazing tip
Welding goggles, safety glasses and face shield
Welding gloves
Portable grinder
Vise
Pliers
Steel plate as selected by instructor
Bronze filler rod as selected by instructor
Flux as selected by instructor
Fire brick work table
Chipping hammer and wire brush

Procedure:

Evaluation
3 2 1 N

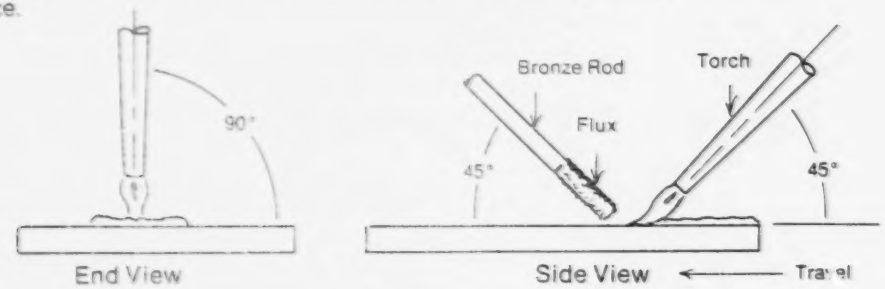
1. Check work area for freedom of flammable materials and proper ventilation. Note the location of the nearest fire extinguisher. Place selected metal in vise and grind surface to remove oxides. — — — —

   CAUTION: Always wear safety glasses and a face shield when grinding.

2. Position metal flat on fire-brick work table. Select recommended brazing tip and finger-tighten on torch. — — — —

3. Set up equipment and light torch according to safety procedures previously outlined. Adjust to slightly oxidizing flame. — — — —

4. Hold the torch at approximately a 90-degree work angle and a 45-degree travel angle, moving it down until flame is about 1/8" from the metal's surface. — — — —



5. Heat an area of the base metal about 1/2" in diameter with a slightly circular torch motion until the metal is dull red. — — — —

6. Insert the end of the rod into an area where the cone of the flame meets the plate immediately after the metal turns dull red. Allow a drop of molten bronze to form the beginning of the bead. — — — —

7. Withdraw rod a short distance. Move the flame forward in a slight circular motion, then reinsert the rod to allow more molten bronze to drop on the plate. — — — —

8. Check the rod frequently to make sure it has flux on it. When the flux is gone, remove the rod and withdraw the flame slightly from the metal as you quickly dip the rod in the flux. — — — —

9. Move flame back on the metal and continue the procedure until the bead is completed. — — — —

10. Stop just as you reach the end of the metal so molten bronze will not drip off the workpiece. Shut off torch. — — — —

11. Inspect bead for consistent width, height and uniform fusion with the base metal. — — — —

NOTE: When too much flux gets on the bead, it may require cleaning before inspection.

12. Repeat the previous procedure until several parallel beads have been made across the sheet metal. Be sure to stop, clean and inspect as each bead is completed. — — — —

13. Ask instructor to check your work. — — — —

14. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

Average of above evaluations* — — — —

*This average is the student's partial evaluation for competency C15: Braze weld carbon steel.

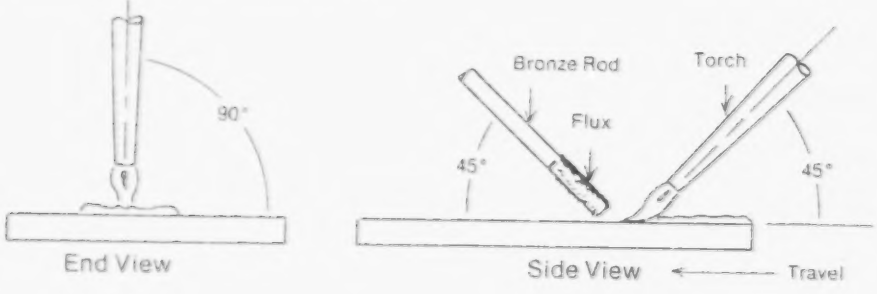
BRAZE WELD CARBON STEEL

Equipment:

Oxyacetylene welding unit with brazing tip
Welding goggles, safety glasses and face shield
Welding gloves
Portable grinder
Vise
Pliers
Steel plate as selected by instructor
Bronze filler rod as selected by instructor
Flux as selected by instructor
Fire brick work table
Chipping hammer and wire brush

Procedure:

		Evaluation 3 2 1 N
1.	Check work area for freedom from flammable materials and proper ventilation. Note the location of the nearest fire extinguisher. Place selected metal in vise and grind surface to remove oxides.	— — — —
	CAUTION: Always wear safety glasses and a face shield when grinding.	
2.	Position metal flat on the fire brick and align pieces about 1/16" apart for a butt joint.	— — — —
	NOTE: Do not lay metal pieces flat on the fire brick. Place other pieces of metal or fire bricks under them so there will be a space between the workpiece and the work table.	
3.	Select recommended brazing tip and put it on the torch finger-tight. Set up equipment and light torch according to safety procedures previously outlined. Adjust to slightly oxidizing flame.	— — — —
4.	Tack each end of the joint. Hold the torch at approximately a 90-degree work angle and a 45-degree travel angle, moving it down until flame is about 1/8" from the surface of the metal.	— — — —



5. Heat about 1/8" of each edge of the joint with a slight circular motion of the torch until they are dull red. — — — —

6. Position the flame in the center of the joint, then insert the rod into the puddle. Allow the puddle to melt the rod. — — — —

7. Withdraw rod a short distance. Move the flame forward in a slight circular motion, then reinsert the rod to allow more molten bronze to enter the joint. — — — —

8. Check the rod frequently to make sure it has flux on it. When the flux is gone, remove the rod and withdraw the flame slightly from the joint as you quickly dip the rod in the flux. — — — —

9. Move flame back into the center of the joint and continue the procedure until the joint is completely brazed. — — — —

10. Stop just as the tack weld metal is covered so molten bronze will not drip off the end of the joint. Shut off torch. — — — —

11. Inspect bead for consistent width, height and uniform fusion with the base metal. Inspect reverse side of joint for penetration. — — — —

CAUTION: Never pick up a piece of hot metal, even when you're wearing leather gloves. Always handle hot metal with a pair of pliers.

12. Ask your instructor to check your work. — — — —

13. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

Average of above evaluations* — — — —

*This average is the student's partial evaluation for competencies C15 and C18.

BRAZE WELD LAP JOINT IN HORIZONTAL POSITION

Equipment:

Oxyacetylene welding unit with brazing tip
Welding goggles, safety glasses and face shield
Welding gloves
Portable grinder
Vise
Pliers
Steel plate as selected by instructor
Bronze filler rod as selected by instructor
Flux as selected by instructor
Fire brick work table
Chipping hammer and wire brush

Procedure:

Evaluation
3 2 1 N

1. Check work area for freedom from flammable materials and proper ventilation. Note the location of the nearest fire extinguisher. Place selected metal in vise and grind surface to remove oxides. — — — —

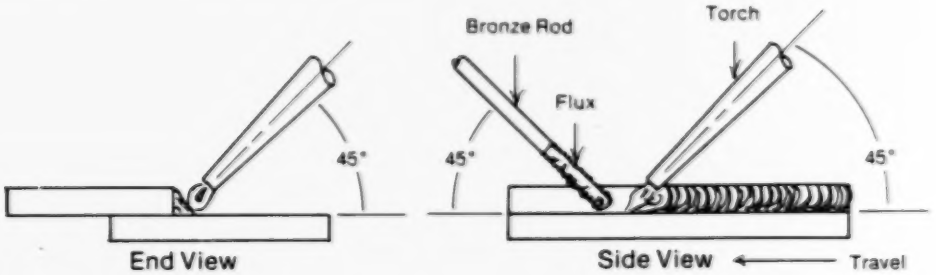
   CAUTION: Always wear safety glasses and a face shield when grinding.

2. Position metal flat on the fire brick and align pieces to form lap joint. — — — —

   NOTE: Do not lay metal pieces flat on the fire brick. Place other pieces of metal or fire bricks under them so there will be a space between the workpiece and the work table.

3. Select recommended brazing tip and put it on the torch finger-tight. Set up equipment and light torch according to safety procedures previously outlined. Adjust to slightly oxidizing flame. — — — —

4. Tack each end of the joint. Hold the torch at approximately a 90-degree work angle and a 45-degree travel angle, moving it down until flame is about 1/8" from the surface of the metal. — — — —



5. Heat about 1/8" of each edge of the joint with a slight circular motion of the torch until dull red. — — — —

6. Position the flame in the center of the joint, then insert the rod into the puddle. Allow the puddle to melt the rod. — — — —

7. Withdraw rod a short distance. Move the flame forward in a slight circular motion, then reinsert the rod to allow more molten bronze to enter the joint. — — — —

8. Check the rod frequently to make sure it has flux on it. When the flux is gone, remove the rod and withdraw the flame slightly from the joint as you quickly dip the rod in the flux. — — — —

9. Move flame back into the center of the joint and continue the procedure until the joint is completely brazed. — — — —

10. Stop just as the tack weld metal is covered so molten bronze will not drip off the end of the joint. Shut off torch. — — — —

11. Inspect bead for consistent width, height and uniform fusion with the base metal. Inspect reverse side of joint for penetration. — — — —

CAUTION: Never pick up a piece of hot metal, even when you're wearing leather gloves. Always handle hot metal with a pair of pliers.

12. Ask your instructor to check your work. — — — —

13. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

Average of above evaluations* — — — —

*This average is the student's partial evaluation for competencies C15 and C18.

BRAZE WELD CAST IRON

Equipment:

Oxyacetylene welding unit with brazing tip
Welding goggles, safety glasses and face shield
Welding gloves
Portable grinder
Vise
Pliers
Cast iron as selected by instructor
Bronze filler rod as selected by instructor
Flux as selected by instructor
Fire brick work table
Chipping hammer and wire brush

Procedure:

Evaluation
3 2 1 N

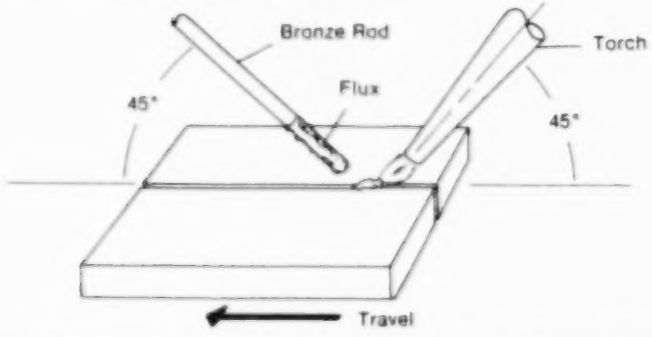
1. Check work area for freedom from flammable materials and proper ventilation. Note the location of the nearest fire extinguisher. Place cast iron in vice and grind surface to remove casting skin. File to remove graphite build-up. — — — —

   CAUTION: Always wear safety glasses and a face shield when grinding.

2. Position metal on the fire brick and align to make butt joint. — — — —

3. Select recommended brazing tip and put it on the torch finger-tight. Set up equipment and light torch according to safety procedures previously outlined. Adjust to slightly oxidizing flame. — — — —

4. Tack each end of the joint. Hold the torch at approximately a 90-degree work angle and a 45-degree travel angle, moving it down until flame is about 1/8" from the surface of the cast iron. — — — —



5. Heat about 1/8" of each edge of the joint with a slight circular motion of the torch until they are dull red. — — — —

6. Position the flame in the center of the joint, then insert the rod into the puddle. Allow the puddle to melt the rod. — — — —

7. Withdraw rod a short distance. Move the flame forward in a slight circular motion, then reinsert the rod to allow more molten bronze to enter the joint. — — — —

8. Check the rod frequently to make sure it has flux on it. When the flux is gone, remove the rod and withdraw the flame slightly from the joint as you quickly dip the rod in the flux. — — — —

9. Move flame back into the center of the joint and continue the procedure until the joint is completely brazed. — — — —

10. Stop just as the tack weld metal is covered so molten bronze will not drip off the end of the joint. Shut off torch. — — — —

11. Inspect bead for consistent width, height and uniform fusion with the base metal. Inspect reverse side of joint for penetration. — — — —

CAUTION: Never pick up a piece of hot metal, even when you're wearing leather gloves. Always handle hot metal with a pair of pliers.

12. Allow the cast iron to slowly cool to room temperature. Ask instructor to check your work. — — — —

13. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

Average of above evaluations* — — — —

*This average is the student's partial evaluation for competency C16.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT IV: ADDITIONAL PROCESSES

LESSON 2: HARD SURFACING

I. Uses

A. Usually confined to only that portion of a part that is subject to critical wear

B. Frequently used on surface areas, edges or points that are subjected to contact or impact wear

C. Usually applied over a base metal selected for general strength and economy. However, the hard surfacing alloy is selected for specific wearing conditions.

D. Increases the life of a part--sometimes by 10 times or more

II. Alloys and characteristics

A. Low-alloy, iron-base alloys: materials that are blended up to 12 percent with chromium, molybdenum or manganese

B. High-alloy, iron-base alloys: materials with 12-50 percent chromium, nickel or cobalt

C. Cobalt-base and nickel-base alloys: contain a small amount of iron; usually cobalt-chromium-tungsten alloys that are expensive but have high resistance to corrosion and oxidation

D. Tungsten-carbide: one of the hardest materials used in industry. For hard surfacing, it is applied with a binding metal.

III. Powders

A. Used primarily on thin base metals that cannot tolerate the heat of conventional arc or oxyacetylene hard surfacing

B. Produce deposits so smooth that some parts can be returned to service with no additional machining

C. Can be sprayed on with spray gun or a hand-held torch assembly. Torch grade powders usually have an improved wetting action.

D. Range from nickel-base alloys for general use to cobalt-based alloys where nickel cannot be used

E. Normally fused onto the base metal with a reducing flame after preheating to 600-800F.

IV. Advantages of hard surfacing with an oxyacetylene torch

A. An oxyacetylene flame can be used with all hard-surfacing alloys.

B. More pounds per hour can be deposited when hard surfacing with arc welding, but dilution of the hard-surfacing alloys is held to a minimum with an oxyacetylene flame.

C. Alloys can be deposited in minimal thicknesses to save expensive materials, and arc processes that can do this are very costly.

D. An oxyacetylene unit can always be taken to the work. With other processes, the work frequently has to be taken to the welding equipment.

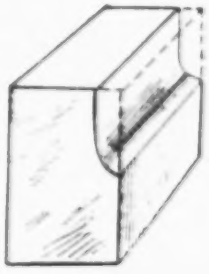
V. Preparation for hard surfacing

A. Thoroughly clean all surfaces so that they are free of scale, dirt, oil or any foreign substance.

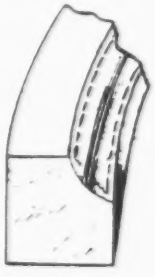
B. Because hard surfacing applications are limited to specific sections of a part, grinding or machining are almost always required.

C. Round off all sharp corners.

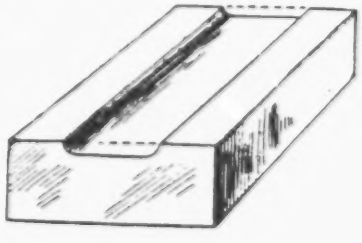
D. When a hard-surfaced edge or corner will be subjected to shock, such as on a punch or shear blade, the steel should be machined as indicated.



E. When a hard-surfaced angle, edge or corner will not be subjected to heavy impact, the steel should be machined as indicated.



F. When hard surfacing is to be applied to a longitudinal area such as a rolling guide, the steel should be machined with a radii equal to the depth of the groove, as indicated.



VI. Preheating and cooling requirements (HO 2.1)

A. Some degree of preheating is required in almost all hard surfacing applications.

B. Larger parts must be fully preheated either with a torch or in a preheating furnace.

C. Parts should not be overheated or a scale may form on the surface. Use temperature-indicating crayons or pellets to be sure.

D. Preheating should be applied evenly to avoid surface cracking.

E. After hard surfacing, the part should be cooled slowly--this is an extremely important factor in the process.

VII. Techniques for oxyacetylene hard surfacing

A. General

1. When working on steel, use a carburizing flame.

2. After preheating, direct the flame onto the surface of the metal at an angle of 30-60 degrees with the tip of the inner cone about 1/8" from the surface.

3. Hold the torch still until the surface sweats (glazed appearance).

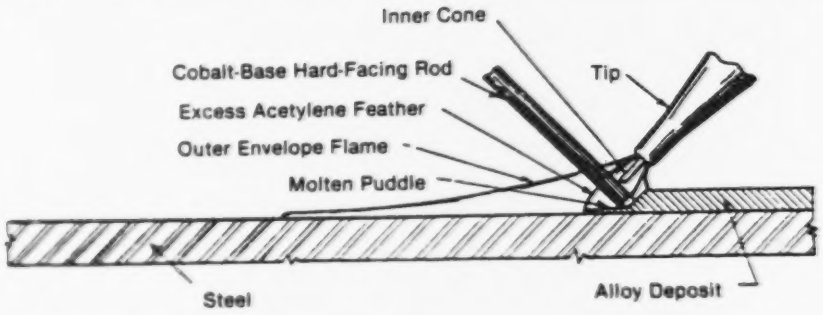
4. Withdraw the flame so that the end of the rod can be brought between the inner cone and the hot base metal. The cone tip will almost touch the rod, and the rod will nearly touch the sweating surface.

5. As the end of the rod melts and forms a puddle on the surface, make sure the first drops spread out uniformly on the surface. If they do not, the base metal needs more preheating.

6. If the first drops spread uniformly, withdraw the rod from the flame and spread the alloy further by directing part of the flame on the puddle and part onto surrounding base metal.

7. As the puddle spreads, put the rod into the flame again with its end touching the puddle. Melt more alloy into the puddle.

8. Alternately move the puddle with the flame and reinsert the rod to deposit more alloy until the surface is covered.



B. Techniques for making a second pass

1. After the first pass is completed, the surface will not sweat, so a second pass requires special attention.

2. Move the puddle by flame pressure--not rod action.

3. Using the forehand technique, work toward the hand holding the rod.

4. When scale or dirt particles appear on the surface, try to float them to the surface with the flame. Use the rod to remove particles only when flame action fails.

5. Cool the part slowly after the final pass is complete.

   NOTE: Controlled cooling can be accomplished by wrapping or burying the part in dry lime, dry sand or wood ashes. In some shops, furnaces with controlled cooling rates are used. Asbestos coverings should not be used.

6. Finish grinding or machining the part to specifications.

VIII. Safety precautions

A. Observe all safety rules for normal set up and operation of oxyacetylene equipment.

B. Keep work area free of flammable materials and know where the nearest fire extinguisher is located.

C. Make sure the area is well ventilated because some fluxes used in hard surfacing contain fluorine compounds that become toxic when vaporized.

D. Take special precautions with steels that have white colored coatings or that turn yellow-gold when torch heated because this means cadmium is present in the protective coating and can generate dangerous fumes as it vaporizes.

E. When parts are cleaned with a vapor-degreaser, make sure the cleaner has dried and all fumes have evaporated before hard surfacing.

METALS PREHEATING CHART

METAL GROUP	METAL DESIGNATION	C.	RECOMMENDED PREHEAT
PLAIN CARBON STEEL	Plain Carbon Steel	Below .20	Up to 200°F
	Plain Carbon Steel	.20 - .30	200°F - 300°F
	Plain Carbon Steel	.30 - .45	300°F - 500°F
	Plain Carbon Steel	.45 - .80	500°F - 800°F
CARBON MOLY STEELS	Carbon Moly Steel	.10 - .20	300°F - 500°F
	Carbon Moly Steel	.20 - .30	400°F - 600°F
	Carbon Moly Steel	.30 - .35	500°F - 800°F
MANGANESE STEELS	Silicon Structural Steel	.35	300°F - 500°F
	Medium Manganese Steel	.20 - .25	300°F - 500°F
	SAE T 1330 Steel	.30	400°F - 600°F
	SAE T 1340 Steel	.40	500°F - 800°F
	SAE T 1350 Steel	.50	600°F - 900°F
	12% Manganese Steel	1.25	Usually Not Required
HIGH TENSILE STEELS	Manganese Moly Steel	.20	300°F - 500°F
	Manten Steel	.30 Max.	400°F - 600°F
	Armco High Tensile Steel	.12 Max.	Up to - 200°F
	Double Strength #1 Steel	.12 Max.	300°F - 600°F
	Double Strength #1A Steel	.30 Max.	400°F - 700°F
	Cr-Cu-Ni Steel	.12 Max.	200°F - 400°F
	Cr-Mn Steel	.40	400°F - 600°F
	Hi-Steel	.12 Max.	200°F - 500°F
NICKEL STEELS	SAE 2015 Steel	.10 - .20	Up to 300°F
	SAE 2115 Steel	.10 - .20	200°F - 300°F
	2 ½% Nickel Steel	.10 - .20	200°F - 400°F
	SAE 2315 Steel	.15	200°F - 500°F
	SAE 2320 Steel	.20	200°F - 500°F
	SAE 2330 Steel	.30	300°F - 600°F
	SAE 2340 Steel	.40	400°F - 700°F

OXYACETYLENE HARD SURFACING

Mark true statements with a T and false ones with an F.

____ 1. Hard-surfacing powders are used primarily on thin base metals that cannot tolerate the heat of conventional arc or oxyacetylene hard surfacing.

____ 2. These powders produce deposits so smooth that some parts can be returned to service with no additional machining.

____ 3. Hard-surfacing powders may be applied with spray gun or a hand-held torch assembly.

____ 4. Powders range from nickel-base alloys for general use to cobalt-based alloys where nickel cannot be used.

____ 5. Powders are normally fused onto the base metal with an oxidizing flame after pre-heating to 600-800F.

____ 6. An oxyacetylene flame can be used with all hard-surfacing alloys.

____ 7. Fewer pounds per hour can be deposited when hard surfacing with arc welding.

____ 8. Alloys can be deposited in minimal thicknesses to save expensive materials.

____ 9. An oxyacetylene unit can't always be taken to the work.

____ 10. Most surfaces to be hard surfaced are thoroughly cleaned so that they are free of scale, dirt, oil or any foreign substance.

____ 11. Because hard-surfacing applications are limited to specific sections of a part, grinding or machining are almost always required.

____ 12. When a hard-surfaced edge or corner is going to be subjected to shock, the steel should not be machined.

____ 13. When hard surfacing is to be applied to a longitudinal area such as a rolling guide, the steel should be machined with a radii equal to the depth of the groove.

____ 14. When working on steel, use a carburizing flame.

____ 15. After preheating, direct the flame onto the surface of the metal at an angle of 30-60 degrees with the tip of the inner cone about 1/8" from the surface.

____ 16. Hold the torch still until the surface sweats and gives a glazed appearance.

____ 17. As the end of the rod melts and forms a puddle on the surface, make sure the first drops spread out uniformly on the surface.

____ 18. As the puddle spreads, put the rod into the flame again with its end touching the puddle. Melt more alloy into the puddle.

___ 19. After the first pass is completed, the surface will sweat more, so a second pass requires special attention.

___ 20. Move the puddle with rod action, not flame pressure.

___ 21. Using the forehand technique, work toward the hand holding the rod.

___ 22. When scale or particles or dirt appear on the surface, try to float them to the surface with the flame.

___ 23. Cool the part slowly after the final pass is complete.

ANSWERS TO ASSIGNMENT SHEET 2.1

1. T
2. T
3. T
4. T
5. F
6. T
7. F
8. T
9. F
10. F
11. T
12. F
13. T
14. T
15. T
16. T
17. T
18. T
19. F
20. F
21. T
22. T
23. T

REPAIR A WORN TOOL WITH HARD SURFACING

Equipment:

Oxyacetylene welding unit with brazing tip
Welding goggles, safety glasses and face shield
Welding gloves
Portable grinder
Vise
Pliers
Worn plow share or other worn equipment as selected by instructor
Hard surfacing rod as selected by instructor
Flux as required
Firebrick work table
Wire brush

Procedure:

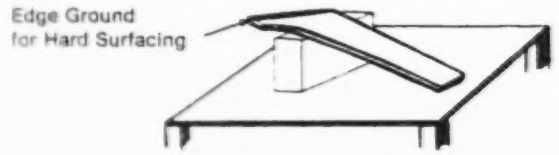
Evaluation 3 2 1 N

1. Check work area to assure that it is free of flammable materials and is properly ventilated. Note the location of the nearest fire extinguisher. — — — —

2. Secure the worn tool in a vise and grind it approximately 1" along the edge until the metal is bright. — — — —

   CAUTION: Always wear safety glasses and a face shield when grinding.

3. Place the tool with one end over a fire brick on the work table so that it is inclined 20-30 degrees. — — — —



Worn Tool or Plow Share

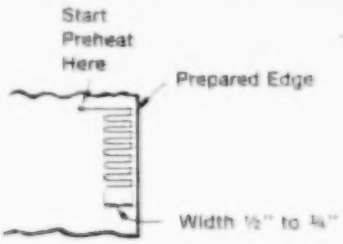
4. Select recommended hard surfacing tip and put in on the torch finger-tight. — — — —

5. Set up equipment and light torch according to safety procedures previously outlined. Adjust to neutral flame for preheating. — — — —

6. Preheat the total length of the edge to be hard surfaced. — — — —

7. Adjust to carburizing flame. Move flame down until it is about 1/8" above the surface of the workpiece. Hold the flame still until the edge surface of the tool begins to sweat and looks glazed. — — — —

8. Withdraw the flame enough so that the end of the rod can be brought between the inner cone and the hot base metal. The tip of the cone will nearly touch the rod, and the rod will almost touch the sweating surface. — — — —



9. Weave the torch slightly and allow a drop or two of molten alloy to drop onto the metal surface. Make sure the molten alloy spreads evenly over the area to be hard surfaced. — — — —

NOTE: If the molten alloy does not flow easily and spread uniformly, it usually indicates the base metal needs more preheating.

10. Withdraw the rod from the flame and spread the alloy further by directing the flame onto the puddle and the surrounding base metal. — — — —

11. Put the rod into the flame again with its end touching the forward side of the puddle and melt more alloy into the puddle. — — — —

12. Move the puddle with flame motion and alternately reinsert the rod to deposit more alloy until the surface is covered. — — — —

13. Shut off torch. Inspect hard surfacing to make sure there is good fusion between the alloy and the base metal. — — — —

14. Ask instructor to check your work. — — — —

15. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

NOTE: Your instructor may instruct you to repeat this job sheet using another selected worn tool.

Average of above evaluations — — — —

MODULE: OXY-FUEL CUTTING/WELDING

UNIT IV: ADDITIONAL PROCESSES

LESSON 3: OXY-FUEL GASES

I. Acetylene

A. Colorless gas with a distinctive garlic-like odor

B. Mixed with oxygen or air in a confined area, acetylene will explode if brought into contact with a flame or heat source.

C. Acetylene should never be used in excess of 15 PSI because it becomes very unstable and may explode.

D. Store acetylene in a well-ventilated room.

E. Acetylene gas, when combined with oxygen, burns at temperatures up to 6,300F.

F. Never use acetylene from a cylinder in the horizontal position because this can separate the acetone from other components and create a dangerous situation.

II. Propane

A. Propane is a colorless gas and is a hydrocarbon present in petroleum and natural gas.

B. Store propane in a well-ventilated area.

C. When combined with oxygen, propane gas burns at temperatures up to 5,190F.

III. Mapp

A. Mapp is a colorless gas with a strong garlic smell.

B. Mapp is an acetylene product that is liquified and stabilized so that it can be used at 375 PSI at 170F.

C. Store mapp gas in a well-ventilated area.

D. When combined with oxygen, mapp gas burns at temperatures up to 5,301F.

IV. Natural gas

A. Natural gas is a tasteless, odorless and colorless gaseous hydrocarbon that has been distilled.

B. It should be stored in a well-ventilated area.

C. Natural gas, when combined with oxygen, burns at temperatures up to 5,000F.

MODULE: OXY-FUEL CUTTING/WELDING

UNIT IV: ADDITIONAL PROCESSES

UNIT TEST

Choose the letter which corresponds to the best answer.

___ 1. If molten bronze forms into drops when braze welding, _____

a. The base metal is not yet hot enough
b. The base metal is too hot
c. The molten bronze will soon bubble and boil
d. The base metal temperature is just right

___ 2. Braze welding is based on the principle that _____ , when raised to the proper temperature, will melt and form a smooth film on the surface of a properly prepared and heated joint.

a. Copper and bronze
b. Brass and copper
c. Brass and bronze
d. Bronze and zinc

___ 3. Tinning cannot be properly accomplished unless the joint has been _____ .

a. Roughly cleaned
b. Roughly prepared
c. Cooled to the proper temperature
d. Thoroughly cleaned and properly prepared

___ 4. Good tinning usually requires a neutral to slightly _____ flame.

a. Carburizing flame and multi-purpose flux
b. Carburizing flame and good brazing flux
c. Oxidizing flame and flux-free filler
d. Oxidizing flame and good brazing flux

___ 5. Improper tinning action is almost always caused by _____ .

a. Overheating the base metal
b. Underheating the base metal
c. Overheated flux
d. Underheated rod

___ 6. Three important factors in successful braze welding are _____ .

a. (1) Cleaning and preparation of the joint, (2) proper tinning of the crucial part of the joint and (3) complete fusion between layers of filler metal if two or more passes are needed.

b. (1) Cleaning and preparation of the joint, (2) proper tinning of every bit of the joint and (3) complete fusion between layers of filler metal if two or more passes are needed.

c. (1) Cleaning and preparation of the joint, (2) proper tinning of every bit of the joint and (3) proper tinning of the crucial part of the joint.

d. (1) Proper tinning of every bit of the joint, (2) complete fusion between layers of filler metal if two or more passes are needed and (3) proper tinning of the crucial part of the joint.

___ 7. Joint preparation for braze welding involves _____ .

a. Removing oxides with a wire brush.
b. Removing oxides with a suitable flux.
c. Removing oxides with a portable grinder.
d. All of the above methods are appropriate.

___ 8. What are some advantages of bronze surfacing?

a. When bronze is applied to steel or cast iron parts subject to sliding friction, the reconditioned parts sometimes give longer service than brand new parts.
b. When large pistons have to be replaced, the cost of bronze surfacing is much less than the cost of a new piston.
c. Cast iron gears can be rebuilt faster at less cost with bronze welding.
d. a and c
e. a, b and c

___ 9. Bronze surfacing is limited in that _____ .

a. It should not be used on parts that will be subjected to temperatures above 800F.
b. Bronze surfacing can frequently be used on parts that will be subjected to alternating tensile and compressive stresses.
c. Bronze surfacing can be used on parts that will not be subjected to alternating tensile and compressive stresses.
d. It should not be used on parts that will be subjected to temperatures above 500F.

___ 10. When preparing for bronze surfacing, _____ .

a. New or almost new surfaces should be filed or ground before bronze is applied.
b. New or almost new surfaces should be machined or ground before bronze is applied.
c. Cast iron surfaces should have excess metal removed by grinding or machining.
d. Cast iron surfaces should have excess metal removed by grinding or wire brushing.

Match the terms or alloys on the right with definitions or characteristics.

___ 11. The process of placing a thin film of filler metal along the joint of a preheated base metal

___ 12. A chemical in paste or powder form used to clean metal, protect from oxidation and promote fusion

___ 13. Contaminants that form in flaky configurations on the surface of a metal

___ 14. The process of mechanically grinding or milling surfaces, edges and corners to precise dimensions on a workpiece to be welded

___ 15. A flame with more oxygen than a neutral flame

___ 16. A flame with more acetylene than a neutral flame

___ 17. Process of making a groove or bevel in a base metal without cutting completely through it

___ 18. Materials that are alloyed up to 12 percent with chromium, molybdenum or manganese

___ 19. Materials with 12-50 percent alloy content of chromium and sometimes nickel and cobalt

___ 20. Materials that contain a small amount of iron that are expensive but have high resistance to corrosion and oxidation

___ 21. One of the hardest materials used in industry; for hard surfacing, is applied with a binding metal

a. Carburizing flame

b. Cobalt-base and nickel-base alloys

c. Flux

d. Gouging

e. High-alloy, iron-base alloys

ab. Low-alloy, iron-base alloys

ac. Machining

ad. Oxidation

ae. Oxidizing flame

bc. Scale

bd. Tungsten-carbide

be. Tinning

Choose the letter which corresponds to the best answer.

___ 22. Hard surfacing is used for _____ .

a. Only that portion of a part that is subject to critical wear
b. Any part
c. Any useful condition
c. Increasing the life of a part by up to five times

___ 23. Which of the following is <u>not</u> a requirement for preheating and cooling when hard surfacing?

a. Preheating is required in almost all hard-surfacing applications.
b. Larger parts must be fully preheated either with a torch or in a preheating furnace.
c. Parts should not be overheated or a scale may form on the surface.
d. After hard surfacing, the part should be cooled quickly.

___ 24. Which of the following is <u>not</u> a safety precaution for hard surfacing?

a. All safety rules for normal set up and operation of oxyacetylene equipment apply.
b. Keep work area free of flammable materials and know where the nearest fire extinguisher is located.
c. Make sure a window is open for ventilation.
d. Take special precautions with steels that have white-colored coatings or that turn yellow-gold when torch heated.
e. When parts have been cleaned with a vapor-degreaser, make sure the cleaner has dried and that all fumes have evaporated before hard surfacing.

___ 25. How are joints for braze welding generally prepared for fusion welding?

a. For thinner base metals
b. For thicker base metals
c. For base metals of like thicknesses
d. None of the above

___ 26. In oxy-fuel welding and cutting, what is the leading fuel gas?

a. Oxygen
b. Propane
c. Acetylene
d. Mapp

___ 27. Which is an acetylene product that is liquified and stabilized so that it can be used at 375 PSI at 170F?

a. Oxygen
b. Propane
c. Acetylene
d. Mapp

___ 28. Which produces hotter flames than acetylene?

a. Propane
b. Propane and natural gas
c. Natural gas
d. Mapp
e. None of the above

ANSWERS TO UNIT TEST

1.	a	(C15)
2.	c	(C15)
3.	d	(C15)
4.	d	(C15)
5.	a	(C15)
6.	b	(C15)
7.	d	(C16)
8.	e	(C16)
9.	c	(C16)
10.	b	(C16)
11.	be	(C16)
12.	c	(C4)
13.	bc	(C18)
14.	ac	(C4)
15.	ae	(C5)
16.	a	(C5)
17.	d	(C7)
18.	ab	
19.	e	
20.	b	
21.	bd	
22.	a	
23.	d	
24.	c	
25.	c	(C16)
26.	c	(C2)
27.	d	(C2)
28.	e	(C2)